MONTGOMERY WATSON

March 11, 1996

United States Environmental Protection Agency
Region V (HSRL-6J)
77 West Jackson Blvd.
Chicago, IL 60604-3590

Project No.: 4077.0100

ATTN: Ms. Sheri Bianchin
Remedial Project Manager

Re: 50 Percent Design Submittal for the
Perimeter Groundwater Containment System
American Chemical Service, Inc. NPL Site
Griffith, Indiana

Dear Ms. Bianchin:

Please find enclosed the 50 Percent Design Submittal for the Perimeter Groundwater Containment System (PGCS) to be implemented at the American Chemical Service, Inc. (ACS) Site. The PGCS is only one component of the overall groundwater remedy for the site as described in the UAO and SOW issued by US EPA. The remaining components will be submitted in subsequent documents including the barrier wall systems design and the final remedial design for the groundwater. The PGCS is being implemented on an expedited schedule to prevent further off-site migration of contaminated groundwater in the upper aquifer.

The design was completed in accordance with the Perimeter Groundwater Containment System RD/RA Work Plan which was submitted in August 1995. As stated in the work plan, the design/build approach is being used to streamline the implementation of the PGCS. Because of this approach, the specific materials and equipment shown on the drawings should be considered preliminary and they are provided for purposes of defining the concepts and the intent of the extraction and treatment systems. Changes will be made as the design is finalized as part of the construction process. Review of the submittal should therefore focus on the design basis, in particular the design criteria, and on the performance standards to be met instead of on specific details.

In accordance with the work plan, the submittal includes the following items:

- Preliminary drawings
- Health and Safety Plan Addendum (for the construction activities)
- Draft Operations and Maintenance/Contingency Plan

- Performance Standard Verification Plan (PSVP)
- Construction Quality Assurance Plan
- Results of the treatability studies and additional sampling
- Design Basis which presents the criteria, parameters, and assumptions used to design the system and also describes the selected extraction and treatment systems
- Proposed cleanup/performance verification methods for the extraction and treatment systems (included in the PSVP)
- Details of the siting and construction of the facilities
- Expected long-term monitoring and operation requirements
- Permit and approval requirements
- Preliminary estimate of the construction and annual operation and maintenance costs

As we prepared the submittal, it became apparent that certain items listed in the work plan were either not necessary or were inconsistent with the design/build approach. The items listed in the work plan, but not included in the submittal are as follows:

- Technical specifications. Specifications are used by the engineer to define for the contractor exactly what materials, equipment, and means of installation are required. Since Montgomery Watson is serving as both the engineer and the contractor for this project, detailed technical specifications are not needed to solicit bids and procure a contractor. Consequently, none are included in the submittal. Specifications for certain materials and equipment will be included in the purchase orders for those items as appropriate.

- QAPP Addendum and Field Sampling Plan. These documents were not prepared since the construction of the PGCS will not require any environmental sampling and analysis.

- Construction Schedule. To avoid duplication and the potential for discrepancies, the schedule for the PGCS construction is not included in the submittal, but is shown on master schedule for the overall project.

Although the document is entitled the 50 Percent Design Submittal, it reflects the 100 percent design level. The only modifications planned for the 100 Percent Design Submittal include those required to address agency comments and the impacts of the recent data collected as part of the groundwater investigation and the barrier wall alignment program. (The extraction trench, for example, will need to be extended further to the east.)

If you have any questions or would like to meet to discuss aspects of the design in more detail, please feel free to contact me at (708) 691-5020.

Sincerely,

MONTGOMERY WATSON

Peter Vagt/RJS

Peter J. Vagt, Ph.D., CPG
Vice President

Enclosure

cc: Holly Grejda/IDEM
ACS Technical Committee

MONTGOMERY WATSON

March 22, 1996

United States Environmental Protection Agency
Region V (HSRL-6J)
77 West Jackson Blvd.
Chicago, IL 60604-3590

Project No.: 4077.0100

ATTN: Ms. Sheri Bianchin

SUBJECT: PGCS 50 Percent Design Submittal
American Chemical Service, Inc. Superfund Site
Griffith, Indiana

Dear Ms. Bianchin:

As we discussed in our meeting on March 14, 1996, Montgomery Watson was to review U.S. EPA and IDEM comments on the Revised Perimeter Groundwater Containment System (PGCS) RD/RA Work Plan and, if necessary, make changes to the PGCS 50 Percent Design Submittal. The enclosures are replacement pages to the design submittal which incorporate the necessary changes. If you need additional information or have any questions or concerns, please don't hesitate to contact me at (708) 691-5020.

Sincerely,

MONTGOMERY WATSON

Peter Vagt/RJS

Peter J. Vagt, Ph.D, CPG
Vice President

Enclosure

cc: Holly Grejda/IDEM
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REPLACEMENT PAGES FOR SECTION 1 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

1.0 INTRODUCTION

1.1 PURPOSE

This 50 Percent Design Submittal for the Perimeter Groundwater Containment System (PGCS) was prepared by Montgomery Watson Americas, Inc. (Montgomery Watson) on behalf of the Respondents to the Unilateral Administrative Order (UAO) issued by the United States Environmental Protection Agency (U.S. EPA), Region V, on September 30, 1994 for the American Chemical Service, Inc. (ACS) Site in Griffith, Indiana. The PGCS is being implemented as one of several expedited activities at the site. The purpose of the PGCS is to prevent further off-site migration of contaminated groundwater in the upper aquifer along the northwestern boundary of the site. It is not the intent of the PGCS to capture and extract the entire contaminated plume within the Area of Attainment. Areas of the contaminated plume not collected and treated with the PGCS will be addressed during the non-expedited remedial design and remedial action phases, as appropriate. The PGCS water treatment plant will also be used to treat decontamination water, condensate, and other aqueous phase material generated by pilot tests and site investigations conducted during the pre-design activities.

The purpose of this design submittal is to document the design concepts and decisions and to provide a mechanism for obtaining concurrance from U.S. EPA and the Indiana Department of Environmental Management (IDEM). This document was prepared in accordance with the PGCS Remedial Design/Remedial Action (RD/RA) Work Plan which was submitted to U.S. EPA and IDEM in August 1995.

1.2 PROJECT BACKGROUND

1.2.1. Site Description

The ACS Site is located at 420 South Colfax Avenue in the City of Griffith, Indiana, which is in the northwestern corner of the state. The site is bordered on the east and northeast by Colfax Avenue. The Chesapeake and Ohio railway bisects the site in a northwest-southeast direction, between the fenced On-Site Area (north) and the Off-Site Area (south). On the west and northwest, south of the Chesapeake and Ohio railway, the site is bordered by the abandoned Erie and Lackawanna railway, and the active portion of the Griffith Municipal Landfill. North of the Chesapeake and Ohio railway, the site is constructed on an expedited basis. The Respondents expressed a similar desire and voluntarily agreed to expedite the design and construction of a groundwater collection and treatment system. The objective of the system is to prevent further off-site migration of contaminants in the upper aquifer along the northwestern perimeter of the site. The system is not intended to remediate the full extent of groundwater contamination, but it will be an integral component of the overall remedy. Additional groundwater remediation activities will be addressed after the extent of contamination has been better defined.

Since the PGCS is the first component of the overall remedy, it is being designed with a high degree of flexibility such that it can easily be integrated with future components of the remedy. For example, the strategy for the site includes the installation of dewatering systems to control migration of contamination from the waste areas and to allow for pilot tests to be conducted in unsaturated material. Water extracted from the dewatering systems will need to be treated. Consequently, the treatment system for the PGCS is being designed to handle waste area flows and to allow for easy expansion if necessary.

The scope of the PGCS design includes the following:

- An extraction trench to cutoff groundwater flow in the upper aquifer along the downgradient perimeter of the site. [Although the SOW states that the extraction system will be composed of wells, a review of the aquifer properties and the local groundwater quality led to the conclusion that an extraction trench would be a more effective hydraulic barrier and would be less susceptible to plugging problems. Therefore, a trench was selected as the preferred extraction system.]

- A treatment system and an associated building and access road.

- A treated groundwater conveyance line and wetlands discharge structures.

To implement the PGCS on an expedited basis, the work is being conducted utilizing the *design/build delivery system*. Under this delivery system, the level of detail in the design documents is less than that which would be required using the design-bid-build delivery system. Consequently, certain components of this design deliverable may not be as detailed as those typically provided with design-bid-build projects. The specific

REPLACEMENT PAGES FOR SECTION 2 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

2.0 DESIGN BASIS

2.1 DESIGN CRITERIA

2.1.1. Sources of Contaminated Water

Although the initial purpose of the treatment system will be to treat groundwater extracted from the trench, it will also need to handle waters generated from other remedial actions at the site. The other activities that will generate contaminated water include:

- Lowering the water table in the On-Site Containment Area (ONCA) as part of a soil vapor extraction (SVE) pilot study and during implementation of the full-scale SVE system;
- Lowering the water table in the Still Bottoms Pond/Treatment Lagoon Area (SBP) after the subsurface barrier wall is installed. (The barrier walls will be installed to: (1) prevent further migration of contaminated groundwater from the waste areas; (2) allow dewatering of the areas while minimizing the volume of water to be treated and thus the overall flow to the treatment system.);
- Lowering the water table in the Off-Site Containment Area (OFCA) after the barrier wall is installed; and

2.1.2. Flow Contributions From Major Sources of Contaminated Water

The hydraulic capacity of the treatment system is based on the contributions of flow from four major sources of contaminated water--the PGCS (i.e., the extraction trench), the ONCA dewatering system, the OFCA dewatering system, and the SBP dewatering system. The flows for the PGCS and ONCA were estimated using information obtained from the recent pump tests, previous information about the upper aquifer, and the MODFLOW groundwater model as described below.

Pump Test. A 24 hour pumping test was conducted at the ACS Site on March 20 and 21, 1995 to evaluate the capacity of the aquifer. The hydraulic conductivity of the aquifer as derived from the pumping test ranged from 1.8 x 10^{-3} to 1.8 x 10^{-2} cm/sec. The average hydraulic conductivity value was 5.8 x 10^{-3} cm/sec. Values for specific yield were in the range of 0.1 to 0.3 (unitless), which are typical of an unconfined sand aquifer. Aquifer tests conducted during the RI yielded an average hydraulic conductivity value for the upper aquifer of 4.0 x 10^{-3} cm/sec, which is consistent with the results of the pumping test. The hydraulic conductivity and specific yield were used in conducting the modelling of the extraction systems.

Groundwater Model. A groundwater model for the site was developed during the RI/FS to aid in the evaluation of the groundwater flow system and to assess various remedial actions. The U.S.G.S. MODFLOW model was implemented, using available site specific data, including aquifer properties developed from the RI aquifer tests, and water level and precipitation data.

The model was used to assist in estimating the probable yield of the PGCS. Visual Modflow (Vmodflow) was used for the modeling, because it uses the same U.S.G.S. Modflow model used in the RI/FS and adds the capability of using the U.S.G.S. Model, Modpath. Modpath is a particle tracking post-processing package that was developed by U.S.G.S to compute three-dimensional path lines based from Modflow output. By using Vmodflow and Modpath, the Modflow output could be used to evaluate the effectiveness of various potential groundwater extraction systems.

Modeling was conducted iteratively, using the flow model component followed by the flow path model and then returning to the flow model. Several different extraction trench alignments were evaluated to assess locations and target drawdowns to provide optimal capture of the flow in the upper aquifer between the ACS facility and the wetlands to the north and west. The results of the modeling were used in designing the extraction trench for the PGCS and the dewatering system for the ONCA.

Since subsurface barrier walls will be installed around the OFCA and SBP, flows from these areas were estimated by calculating the volume of water to be removed and dividing by the desired dewatering period. The volume of water to be removed was assumed to be equal to the volume of the saturated zone (above the silty clay) within the area to be dewatered multiplied by an assumed porosity (0.3 for the OFCA and 0.4 for the SBP). As the water table is drawn down to the desired level, the flow will decrease. Once the water table has been lowered, the flow will be equal to the amount of infiltration into the area. Data suggest that some upward flow may exist in this area through the silty clay, but for the purposes of the dewatering calculations it has not been included. For the design, it was assumed that the dewatering of the two areas would be accomplished concurrently over a five year period.

The flow contributions from the small areas within the SBP and OFCA which will be dewatered for pilot testing are unknown at this time. The current plan is to install temporary sheet pile or other type of barrier walls to minimize the volume of water to be extracted. Since these test areas will be located in the most contaminated portions of the site, the extracted groundwater will have high concentrations of contaminants. If possible, the water will be stored in tanks and gradually bled into the treatment system influent. If this approach is not feasible, the water will be properly disposed of at a permitted off-site facility.

Since there are several sources of water, nearly all of which have high flows for a short initial period and then lower flows once steady-state conditions are reached, it is essential to develop a schedule for staggering the activities such that the most appropriate treatment system can designed to meet the project's needs. This approach will avoid the need to design and construct a treatment system to accomodate short duration or limited flows. A schedule for staggering the startup and operation of each of the water-producing activities and the resulting estimated flows to the treatment system is presented in Table 2-1. The schedule is based on the following strategy:

Stage 1: Startup the PGCS (the extraction trench) at an initial flowrate of approximately 40 to 45 gallons per minute (gpm).

Stage 2: As the extraction trench system reaches steady-state, the flow will decrease. After six months of operation, the flow should be approximately 15 gpm. At this time, the dewatering for the SVE pilot study in the ONCA can begin. Theinitial flow from this system is estimated to be 18 gpm. Total flow to the treatment system from these two sources will be 33 gpm.

REPLACEMENT PAGES FOR SECTION 3 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

3.0 PERMIT/APPROVAL REQUIREMENTS

As previously discussed, the remedial activities are being conducted pursuant to a Unilateral Administrative Order (UAO) which defines the framework under which the remedial design and remedial action is to proceed. The UAO states in paragraph 28 that the actions required by the UAO are consistent with the National Contingency Plan, as ammended, and CERCLA. Paragraph 52 goes further to state that permits are not required for any on-site activities. Given these facts, no permits are needed for construction or operation of the PGCS where these activities are conducted on site. Thus, design concepts and details have considered, as appropriate, compliance with the intent of applicable laws or regulations, even though permits will not be required. Key regulatory programs which have been evaluated are discussed in the following paragraphs.

3.1 EFFLUENT DISCHARGE QUALITY CRITERIA

Treated groundwater from the PGCS treatment facility will be discharged to the adjacent wetlands which are located on site. As stated in the NCP and the UAO, a permit for discharging the effluent is not required since the discharge point will be on site; however, IDEM has issued effluent limits. Table 2-4 in Section 2.0 provides the effluent limits for discharge of treated groundwater to the adjacent wetlands.

3.2 WETLANDS DISCHARGE REQUIREMENTS

An evaluation of potential impacts that the discharge of treated effluent might cause to the wetlands was performed by reviewing the historical water levels, the existing plant species, and the aerial extent of the wetlands; conducting hydrogeologic modeling; and identifying the invert elevations of outlets from the wetlands. The following are the major findings:

- The wetlands is fairly large (about 25 acres) and the maximum amount of water to be discharged is relatively small (60 gpm).

- The groundwater to be removed and treated would discharge to the wetlands anyway if the proposed extraction trench is not constructed. Therefore, the discharge of this treated effluent to the wetland will not significantly change the overall water balance in the wetlands.

- The hydrogeologic modeling indicates that ponding/flooding of the wetlands will not occur.

- The wetlands has an outlet via a ditch and culvert under the railroad tracks to the south. The outlet will control the water level in the wetlands.

Based on the evaluation, the discharge of treated groundwater will have no adverse impacts on the wetlands. Construction activities in or near wetland areas are normally governed by the Corps of Engineers. Since the ACS site is a Superfund site, the Corps of Engineers has stated that they will relegate the decision-making authority to the lead agency—U.S. EPA—and therefore no specific permits or approvals are needed from the Corps. The Corps of Engineers requested that a letter be sent to them describing the proposed activity and the circumstances. The Corps of Engineers then responded with written confirmation that a permit is not needed.

3.3 WELL INSTALLATION REQUIREMENTS

Pursuant to CERCLA and UAO authorization, no permits are required for well installation at the ACS Site. Design and construction details regarding well installation will be prepared in advance of construction activities and submitted to the U.S. EPA and IDEM for approval.

3.4 CONSTRUCTION/BUILDING PERMIT

Pursuant to CERCLA and UAO authorization, no permits are required for installation of a treatment building at the ACS Site. However, the building design, including the foundation and structural design, will meet the applicable state and local guidelines and building codes. In addition to meeting the building codes, the building will also meet the requirements of the Indiana Fire Prevention Code.

3.5 AIR DISCHARGE REQUIREMENTS

Within the CERCLA authorization, no permits are required for discharge to the atmosphere. However, the PGCS treatment facility would have to meet the intent of federal, state, and local guidelines regarding air emissions. A letter has been sent to U.S. EPA and IDEM with information regarding the treatment facility design and operations, an estimate of air emissions, and the measures and means to comply with the air emissions guidelines.

3.6 UTILITY CONNECTIONS

The utility connections required for the PGCS construction and operation include water (both fire water and potable water), sanitary sewer, natural gas, and electric power supply. The permit/approval requirement for each connection is described below.

3.6.1. Water

Potable and fire water for the PGCS treatment facility will be brought to the treatment system building by installing a new line from the water main recently installed in Colfax Avenue. A separate meter will also need to be installed.

3.6.2. Sanitary Sewer Connection

Waste from the restroom and the laboratory located inside the treatment facility building will be discharged to the City of Griffith sanitary sewer. A new connection will need to be provided for the sanitary waste from the PGCS treatment facility. The City of Griffith stated that it will require a new sewer connection permit before the tie-in can be made. The tie-in will have to meet the City of Griffith requirements and codes, and will have to be approved by a City inspector before discharge can be made to the sewer. The City will assess their sewer connection fee as part of the application.

3.6.3. Natural Gas and Power Supply

Natural gas and electricity are currently available at the ACS Site. These utilities are provided by the Northern Indiana Public Service Company (NIPSCO). Telephone conversations with Mr. Larry McDonald of NIPSCO suggest that a new gas and power

REPLACEMENT PAGES FOR SECTION 4 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

TABLE 4-1

ESTIMATED COSTS
PERIMETER GROUNDWATER CONTAINMENT AND TREATMENT SYSTEM DESIGN/BUILD CONSTRUCTION

Item Number	Capital Costs Description		Cost
1	Permits/ Notifications		$2,300
2	Construction Surveying		$9,000
3	Temporary Services		$40,000
4	Site Preparation		$79,000
5	General Earthwork		$265,000
6	Underground Utilities		$65,000
7	Perimeter Groundwater Extraction Trench		$270,000
8	Groundwater Treatment Building		$350,000
9	Laboratory Furnishings and Equipment		$46,000
10	Treatment Equipment and Installation		$1,121,000
		Subtotal	$2,247,300
11	Contractor's Labor and Expenses		$326,000
		Subtotal	$2,573,300
12	Contractor's Insurance, Overhead, and Profit		$322,000
		Subtotal	$2,895,300
13	Engineering Oversight and Technical Support		$186,000
	Total Project Capital Cost		**$3,081,300**

Item Number	O & M Costs Description	Annual Cost
1	Power	$59,000
2	Lamp Replacement	$10,000
3	Chemicals	$81,000
4	Carbon	$15,000
5	Sludge Disposal (as nonhazardous waste)	$26,000
6	Labor (2 shifts per weekday plus 1 shift each weekend day)	$249,600
7	Equipment Maintenance	$12,500
8	Compliance Monitoring	$30,000
9	Process Monitoring	$25,000
	Total Annual O&M Costs	**$508,100**

REPLACEMENT PAGES FOR SECTION 7 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

- In-situ vapor extraction of contaminated soils;
- Continued evaluation and monitoring of wetlands and, if necessary, remediation;
- Long-term groundwater monitoring;
- Fencing the Site and implementation of deed and access restrictions and deed notices; and
- Private well sampling with possible well closures or groundwater use advisories.

During meetings held early in 1995 with the Respondents, U.S. EPA, and IDEM, the agencies expressed a desire to have some components of the remedy designed and constructed on an expedited basis. The Respondents expressed a similar desire and voluntarily agreed to expedite the design and construction of a groundwater collection and treatment system. The objective of the system is to prevent further off-site migration of contaminants in the upper aquifer along the northwestern perimeter of the site. The system is not intended to remediate the full extent of groundwater contamination, but it will be an integral component of the overall remedy. Additional groundwater remediation activities will be addressed after the extent of contamination has been better defined.

Since the PGCS is the first component of the overall remedy, it is being designed with a high degree of flexibility such that it can easily be integrated with future components of the remedy. For example, the strategy for the site includes the installation of dewatering systems to control migration of contamination from the waste areas and to allow for pilot tests to be conducted in unsaturated material. Water extracted from the dewatering systems will need to be treated. Consequently, the treatment system for the PGCS is being designed to handle waste area flows and to allow for easy expansion if necessary.

1.3 GROUNDWATER CHARACTERIZATION

1.3.1. Sources of Groundwater

Although the initial purpose of the treatment system will be to treat groundwater extracted from the trench, it will also need to handle waters generated from other remedial actions at the site. The other activities that will generate contaminated water include:

- Lowering the water table in the On-Site Containment Area (ONCA) as part of a soil vapor extraction (SVE) pilot study and during implementation of the full-scale SVE system;

- Lowering the water table in the Still Bottoms Pond/Treatment Lagoon Area (SBP) after the subsurface barrier wall is installed. (The barrier walls will be installed to: (1) prevent further migration of contaminated groundwater from the waste areas; (2) allow dewatering of the areas while minimizing the volume of water to be treated and thus the overall flow to the treatment system.);

- Lowering the water table in the Off-Site Containment Area (OFCA) after the barrier wall is installed; and

A description of the anticipated flow and the nature of contaminants associated with liquids from each source area is presented in the following sections.

1.3.2. Flow and Scheduling of Groundwater

The hydraulic capacity of the treatment system will be based on the contributions of flow anticipated from the four source streams (the PGCS, ONCA, OFCA, and SBP). The flows for the PGCS and ONCA were estimated using the recent pump test data, basic assumptions about the aquifer properties, and the MODFLOW groundwater model.

Since subsurface barrier walls will be installed around the OFCA and SBP, flows from these areas were estimated by calculating the volume of water to be removed and dividing by the desired dewatering period. The volume of water to be removed was assumed to be equal to the volume of the saturated zone (above the silty clay) within the area to be dewatered multiplied by an assumed porosity (0.3 for the OFCA and 0.4 for the SBP). As the water table is drawn down to the desired level, the flow will decrease. Once the water table has been lowered, the flow will be equal to the amount of infiltration into the area. Data suggest that some upward flow may exist in this area through the silty clay, but for the purposes of the dewatering calculations it has not been included. For the design, it was assumed that the dewatering of the two areas would be accomplished concurrently over a five year period.

The flow contributions from the small areas within the SBP and OFCA which will be dewatered for pilot testing are unknown at this time. The current plan is to install temporary sheet pile or other type of barrier walls to minimize the volume of water to be extracted. Since these test areas will be located in the most contaminated portions of the site, the extracted groundwater will have high concentrations of contaminants. If possible, the water will be stored in tanks and gradually bled into the treatment system influent. If this approach is not feasible, the water will be properly disposed of at a permitted off-site facility.

Since there are several sources of water, nearly all of which have high flows for a short initial period and then lower flows once steady-state conditions are reached, it is essential to develop a schedule for staggering the activities such that the most appropriate treatment system can designed to meet the project's needs. This approach will avoid the need to design and construct a treatment system to accomodate short duration or limited flows. A schedule for staggering the startup and operation of each of the water-producing activities and the resulting estimated flows to the treatment system is presented in Table 1-1. The schedule is based on the following strategy:

Stage 1: Startup the PGCS (the extraction trench) at an initial flowrate of approximately 40 to 45 gallons per minute (gpm).

REPLACEMENT PAGES FOR SECTION 8 OF THE PGCS 50 PERCENT DESIGN SUBMITTAL

8.0 PERFORMANCE STANDARD VERIFICATION PLAN

8.1 INTRODUCTION

This section presents the Performance Standard Verification Plan (PSVP) that will be implemented at the ACS Site for the Perimeter Groundwater Containment System (PGCS). The purpose of the PSVP is to delineate the approach to be used to measure performance and to ensure that both short-term and long-term performance standards for this portion of the remedial action are met. The performance standards for this portion of the remedy are:

- Hydraulic containment (determined based on water level measurements) of groundwater in the upper aquifer along the northwestern boundary of the site,
- Declining VOC concentrations in monitoring wells downgradient of the trench, and
- Water quality standards established for discharge of the treated groundwater.

No other performance standards, such as the groundwater remediation levels, are applicable since the objective of the PGCS as stated in the RD/RA Work Plan is containment, not restoration. The final remedy for the site will address restoration of the groundwater. Also, this PSVP does not include monitoring the water quality of the contaminant plume since this will be accomplished through the quarterly monitoring program.

The PSVP for this portion of the remedy includes the following plans:

- A Quality Assurance Project Plan (QAPP) which presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the remedial action at the ACS Site. The QAPP also describes the specific protocols to be followed for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses. A Draft QAPP for the ACS Site was submitted in August 1995. An addendum to the QAPP will be included as Attachment A of the Final PSVP.

- A site-specific Health and Safety Plan (HSP) designed to protect on-site personnel and area residents from physical, chemical and all other hazards posed by the remedial action. A Draft HSP for the ACS Site was submitted in August 1995. An addendum to the HSP will be included as Attachment B of the Final PSVP.

- A Performance Monitoring Program which delineates the field measurements, sampling, and analyses to be conducted to monitor the performance of the PGCS.

8.2 PERFORMANCE MONITORING PROGRAM

The PGCS has two components that require performance monitoring: (1) the extraction trench, and (2) the treatment system.

8.2.1. Extraction Trench

The purpose of the extraction trench is to achieve hydraulic containment of contaminated groundwater in the upper aquifer along the northwestern boundary of the ACS Site. Existing monitoring wells and piezometers in conjunction with 12 new piezometers will be used to obtain water level measurements. The 12 new piezometers will be installed to monitor groundwater levels in and near the trench. The 12 piezometers will be installed in four clusters each with three piezometers. Two clusters will be located in the northern leg of the trench, one about 200 feet east of the intersection of the trench legs and the other about 440 feet east. The other two clusters will be located one third of the distance along the main length of the trench. One piezometer from each cluster will be installed in the trench; one will be installed 25 feet upgradient, perpendicular to the trench; and one will be installed 25 feet downgradient, perpendicular to the trench. Existing piezometers P-23 through 27 located in the vicinity of the trench will also be used for monitoring purposes. In addition, existing piezometers P-28, P-40, and P-41 and existing monitoring wells MW4 and MW11, which are located upgradient and crossgradient, will be used as reference points for assessing drawdown in the trench. Periodic water level measurements will be conducted on each piezometer and monitoring well. The water level data will be used to generate groundwater contour maps for evaluating the capture zone of the trench. A preliminary schedule for water level measurements is presented below.

Piezometer/ Monitoring Well	Cumulative Time from Startup	Frequency
All listed in text	3 months prior to	Once per week
All listed in text	0 to 7 days	Once per day
All listed in text	8 to 30 days	Once per week
All listed in text	31 days to 1 year	Once per month
All listed in text	1 year onward	Once per quarter

In addition to hydraulic containment, performance of the extraction trench will be measured based on the concentrations of VOCs in the existing and proposed monitoring wells downgradient of the trench. If the concentrations follow a declining trend with time (to be evaluated after 12 quarters), it will be deemed as further evidence that the trench is providing containment. The monitoring wells will be sampled once prior to startup of the extraction trench and then they will be monitored as part of the quarterly monitoring program thereafter. Sampling and analytical protocols will be as specified for the quarterly monitoring program.

8.2.2. Treatment System

The purpose of the groundwater treatment system is to reduce the concentrations of contaminants to acceptable levels prior to discharge to the wetlands. The acceptable levels are the effluent quality standards established by IDEM and U.S. EPA, and as agreed to by the ACS PRP Group. Samples of the treated groundwater will be collected from the effluent sump located in the treatment building. A preliminary schedule of the sampling frequency and analytes is shown in Table 8-1.

TABLE 8-1

GROUNDWATER TREATMENT SYSTEM PERFORMANCE MONITORING PROGRAM

Analytes	Cumulative Time from Startup	Frequency
Flowrate and pH	—	Continuous
BOD, TSS, SVOCs, and Metals	0 to 7 days	Once per day
	8 to 30 days	Once per week
	31 to 180 days	Once per month
	181 days onward	Once per quarter
VOCs	0 to 7 days	Once per day
	8 to 30 days	Once per week
	31 days onward	Once per month
PCBs	0 to 7 days	Once
	8 to 30 days	Once
	31 to 180 days	Twice
	181 days onward	Twice per year
PCBs in sediment (one location)	--	Once per year

CLIENT REVIEW DRAFT

PERIMETER GROUNDWATER CONTAINMENT SYSTEM 50 PERCENT DESIGN SUBMITTAL

AMERICAN CHEMICAL SERVICE, INC. NPL SITE

GRIFFITH, INDIANA

MARCH 1996

PREPARED FOR:

ACS RD/RA EXECUTIVE COMMITTEE

PREPARED BY:

MONTGOMERY WATSON AMERICAS, INC.

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DRAWINGS BOUND SEPARATELY

Section 1

1.0 INTRODUCTION

1.1 PURPOSE

This 50 Percent Design Submittal for the Perimeter Groundwater Containment System (PGCS) was prepared by Montgomery Watson Americas, Inc. (Montgomery Watson) on behalf of the Respondents to the Unilateral Administrative Order (UAO) issued by the United States Environmental Protection Agency (U.S. EPA), Region V, on September 30, 1994 for the American Chemical Service, Inc. (ACS) Site in Griffith, Indiana. The PGCS is one component of the overall remedy for the site as described in the UAO and Statement of Work (SOW) issued by U.S. EPA. The PGCS is being implemented as one of several expedited activities at the site. The purpose of the PGCS is to prevent off-site migration of contaminated groundwater in the upper aquifer. It is not the intent of the PGCS to capture and extract the entire contaminated plume within the Area of Attainment. Areas of the contaminated plume not collected and treated with the PGCS will be addressed during the non-expedited remedial design and remedial action phases, as appropriate. The PGCS water treatment plant will also be used to treat decontamination water, condensate, and other aqueous phase material generated by pilot tests and site investigations conducted during the pre-design activities.

The purpose of this design submittal is to document the design concepts and decisions and to provide a mechanism for obtaining concurrance from U.S. EPA and the Indiana Department of Environmental Management (IDEM). This document was prepared in accordance with the PGCS Remedial Design/Remedial Action (RD/RA) Work Plan which was submitted to U.S. EPA and IDEM in August 1995.

1.2 PROJECT BACKGROUND

1.2.1. Site Description

The ACS Site is located at 420 South Colfax Avenue in the City of Griffith, Indiana, which is in the northwestern corner of the state. The site is bordered on the east and northeast by Colfax Avenue. The Chesapeake and Ohio railway bisects the site in a northwest-southeast direction, between the fenced On-Site Area (north) and the Off-Site Area (south). On the west and northwest, south of the Chesapeake and Ohio railway, the site is bordered by the abandoned Erie and Lackawanna railway, and the active portion of the Griffith Municipal Landfill. North of the Chesapeake and Ohio railway, the site is bordered on the west by wetland areas. The northern boundary of the site is formed by the Grand Trunk railway.

There are five land disposal areas at the ACS Site: the On-Site Containment Area (ONCA), the Still Bottoms Pond (SBP) Area, the Treatment Lagoons, the Off-Site Containment Area (OFCA), and the Kapica/Pazmey Area[1]. Although the Griffith Municipal Landfill is located within the boundaries of the site, it is not included as part of the remedy. The landfill is an active solid waste disposal facility that has operated since the 1950s and it is currently going through closure.

1.2.2. Operational History

Based on information provided by American Chemical Service, Inc., the ACS facility began operation in May 1955 as a solvent recovery facility. Solvent recovery remained the primary operation performed on-site through in the late 1960s, when the manufacture of small quantities of specialty chemicals began. These manufacturing operations included treating rope with fungicide, bromination and treating ski cable.

In 1961, ACS sold a two-acre parcel to John Kapica, and in 1962 Kapica began the operation of his drum reclaiming business at the location. Operations at Kapica Drum, Inc., consisted of drum reconditioning. Kapica Drum was sold to Pazmey Corporation in February 1980. Kapica/Pazmey operated from 1980 to 1987. The Pazmey Corporation property was sold to Darija Djurovic in March 1987.

ACS' solvent operations involved spent solvent mixtures containing alcohols, ketones, esters, chlorinated solvents, aromatics, aliphatics, and glycols. In the early years of operation, spent solvents were stored in 55-gallon drums at various locations at the Site. Solvent recovery was performed in batch evaporation units, which were charged by pumping material directly from 55-gallon drums into the evaporation vessels. Still bottoms from the evaporation vessels were disposed in the Still Bottom Pond, prior to the installation of incinerators at the facility. ACS installed its first incinerator in 1966 and installed a second incinerator in 1969. The incinerators were used to burn still bottoms

[1] The terms On-Site and Off-Site are used to denote particular portions of the ACS Site: both areas are within the CERCLA Site. The Off-Site Containment area is designated as off-site only because it is adjacent to, rather than within the boundaries of the property where ACS currently conducts its chemical formulation operations. However, ACS owns the property and as noted, for CERCLA purposes, both of these areas are considered on-site.

and non-reclaimable materials generated at the site, and wastes from off-site. The incinerator units were dismantled in 1977.

From 1970 to 1975, the spent solvents reclaimed at the site were similar to those which were handled in the 1960s. However, an increasing percentage of shipments were received at the site in bulk tanker trucks. In addition, the batch manufacturing processes were expanded during this period. A lard oil process which utilized tallow and animal rendering was used to manufacture a lubricant product. This process, along with a soldering flux operation, was discontinued prior to 1990. In 1971, the additive manufacturing area was built. Various detergents lubricants, and chemical additives were manufactured, in addition to soldering flux, various amines, methanol, formaldehyde, sodium hydroxide, and maleic anhydride. An epoxidation plant was constructed in 1974 and a bromination operation using hexane was added in 1975. At various times up until 1990, the epoxidation plant used toluene or benzene as a reaction carrier.

Some time between 1975 and 1990, the solvent distillation units were replaced with new units though the types of solvent wastes reclaimed remained essentially the same. Spent solvent and reclaimed solvent recovery tank farms were constructed during this time period and the majority of the spent solvent waste streams were shipped in bulk tanker trucks, although drummed wastes were still processed. A hazardous waste drum unloading dock and storage area were built in the early 1970s, with spill containment curbing and a sump area added at a later date. In September 1990, ACS ceased accepting hazardous waste shipments and filed for closure. On March 31, 1993 ACS completed closure and terminated its interim RCRA status. ACS currently operates as a chemical production facility at the site.

1.2.3. Land Disposal History

When ACS began operations in 1955, the still bottoms from the solvent recovery operations were disposed of in the Still Bottoms Pond/Treatment Lagoon area. In 1972, the pond and lagoons were drained, and drums, partially filled with sludge materials, were landfilled there.

The OFCA was utilized for the landfilling of wastes including excavated materials from the Still Bottoms/Treatment Lagoon from 1958 to 1975. The waste types disposed of in the OFCA over the course of ACS' operations also included general refuse, drums, still bottoms and incinerator ash. According to the ACS, Inc. owner/operators, drums placed in the OFCA were crushed or punctured as part of the disposal process.

During the mid-1960s, it is estimated that approximately 400 drums of sludge and semi-solids were landfilled in the ONCA. Observations made during test pit excavations in 1993 did not detect any intact drums. Residual wastes and rinse waters from the Kapica/Pazmey drum reconditioning operation were disposed of on the ground in the Kapica/Pazmey Area.

1.2.4. Administrative History

In February 1980, the U.S. EPA performed a Preliminary Assessment of the ACS Site, collecting samples in the Off-Site Containment Area and at the Griffith Municipal Landfill in May 1980. The U.S. EPA performed a site inspection on September 9, 1980, and in July 1982, U.S. EPA contractors installed four monitoring wells near the Off-Site Containment Area and the Griffith Landfill. Based upon information developed during these investigative efforts, a hazard ranking system score of 34.98 was assigned to the ACS Site by U.S. EPA in June 1983.

In 1986, a group of approximately 125 Potentially Responsible Parties (PRPs) formed a Steering Committee to conduct the Remedial Investigation/Feasibility Study (RI/FS) pursuant to an agreement with the U.S. EPA. The PRPs signed a Consent Order to perform the RI/FS in June 1988. Following U.S. EPA approval of the RI/FS Work Plan, the field investigation for Phase I of the RI began in July 1989. Phase II RI field work began in March 1990, and in December 1990, the Phase III RI field work was initiated. The RI report was completed in June 1991. Warzyn (now Montgomery Watson Americas, Inc.) completed the FS report in June 1992.

In June 1992, the U.S. EPA published notice of its Proposed Plan for Remedial Action for the ACS Site. The remedy presented in that Proposed Plan was described by U.S. EPA as a modification of Remedial FS Alternative 6B. The U.S. EPA issued a Record of Decision (ROD) in September 1992. The UAO was issued on September 30, 1994. The Respondents provided notice to the U.S. EPA of their intent to comply with the UAO, and have developed the planning documents and performed other tasks required by the UAO to date.

1.3 SCOPE OF THE PERIMETER GROUNDWATER CONTAINMENT SYSTEM DESIGN

The remedy presented in the ROD for the ACS Site includes the following components:

- Groundwater pumping and treatment to dewater the site and to contain the contaminant plume with subsequent discharge of the treated groundwater to surface water and wetlands;
- Excavation of approximately 400 buried drums in the ONCA for off-site incineration;
- Excavation of buried waste materials and treatment by low temperature thermal treatment (LTTT);
- On-site treatment or off-site disposal of treatment condensate;
- Vapor emission control during excavation and possible immobilization of inorganic contaminants after LTTT;
- Off-site disposal of miscellaneous debris;
- In-situ vapor extraction pilot study of buried waste in the On-site Area;
- In-situ vapor extraction of contaminated soils;
- Continued evaluation and monitoring of wetlands and, if necessary, remediation;
- Long-term groundwater monitoring;
- Fencing the Site and implementation of deed and access restrictions and deed notices; and
- Private well sampling with possible well closures or groundwater use advisories.

During meetings held early in 1995 with the Respondents, U.S. EPA, and IDEM, the agencies expressed a desire to have some components of the remedy designed and constructed on an expedited basis. The Respondents expressed a similar desire and voluntarily agreed to expedite the design and construction of a groundwater collection and treatment system. The objective of the system is to prevent off-site migration of contaminants in the upper aquifer along the downgradient perimeter of the site. The system is not intended to remediate the full extent of groundwater contamination, but it will be an integral component of the overall remedy. Additional groundwater remediation activities will be addressed after the extent of contamination has been better defined.

Since the PGCS is the first component of the overall remedy, it is being designed with a high degree of flexibility such that it can easily be integrated with future components of the remedy. For example, the strategy for the site includes the installation of dewatering systems to control migration of contamination from the waste areas and to allow for pilot tests to be conducted in unsaturated material. Water extracted from the dewatering systems will need to be treated. Consequently, the treatment system for the PGCS is being designed to handle waste area flows and to allow for easy expansion if necessary.

The scope of the PGCS design includes the following:

- An extraction trench to cutoff groundwater flow in the upper aquifer along the downgradient perimeter of the site. [Although the SOW states that the extraction system will be composed of wells, a review of the aquifer properties and the local groundwater quality led to the conclusion that an extraction trench would be a more effective hydraulic barrier and would be less susceptible to plugging problems. Therefore, a trench was selected as the preferred extraction system.]

- A treatment system and an associated building and access road.

- A treated groundwater conveyance line and wetlands discharge structures.

To implement the PGCS on an expedited basis, the work is being conducted utilizing the *design/build delivery system.* Under this delivery system, the level of detail in the design documents is less than that which would be required using the design-bid-build delivery system. Consequently, certain components of this design deliverable may not be as detailed as those typically provided with design-bid-build projects. The specific materials and equipment shown on the drawings should therefore be considered preliminary since they may change as the design evolves throughout the construction process. As discussed in the PGCS RD/RA Work Plan, however, the system will be designed and constructed to meet the requirements of Section E on page 4 of the Statement of Work (SOW) issued by U.S. EPA. With the above in mind, review of this submittal should focus on the design basis, in particular the design criteria, and on the performance standards to be met instead of on specific details.

Section 2

2.0 DESIGN BASIS

2.1 DESIGN CRITERIA

2.1.1. Sources of Contaminated Water

Although the initial purpose of the treatment system will be to treat groundwater extracted from the trench, it will also need to handle waters generated from other remedial actions at the site. The other activities that will generate contaminated water include:

- Lowering the water table in the On-Site Containment Area (ONCA) as part of a soil vapor extraction (SVE) pilot study and during implementation of the full-scale SVE system;

- Lowering the water table in the Still Bottoms Pond/Treatment Lagoon Area (SBP) after the subsurface barrier wall is installed. (The barrier walls will be installed to: (1) prevent further migration of contaminated groundwater from the waste areas; (2) allow dewatering of the areas while minimizing the volume of water to be treated and thus the overall flow to the treatment system.);

- Dewatering of a small area within the SBP during a SVE pilot study;

- Lowering the water table in the Off-Site Containment Area (OFCA) after the barrier wall is installed; and

- Dewatering of a small area within the OFCA during the excavation, material handling, and low temperature thermal treatment pilot study.

2.1.2. Flow Contributions From Major Sources of Contaminated Water

The hydraulic capacity of the treatment system is based on the contributions of flow from four major sources of contaminated water--the PGCS (i.e., the extraction trench), the ONCA dewatering system, the OFCA dewatering system, and the SBP dewatering system. The flows for the PGCS and ONCA were estimated using information obtained from the recent pump tests, previous information about the upper aquifer, and the MODFLOW groundwater model as described below.

Pump Test. A 24 hour pumping test was conducted at the ACS Site on March 20 and 21, 1995 to evaluate the capacity of the aquifer. The hydraulic conductivity of the aquifer as derived from the pumping test ranged from 1.8 x 10^{-3} to 1.8 x 10^{-2} cm/sec. The average hydraulic conductivity value was 5.8 x 10^{-3} cm/sec. Values for specific yield were in the range of 0.1 to 0.3 (unitless), which are typical of an unconfined sand aquifer. Aquifer tests conducted during the RI yielded an average hydraulic conductivity value for the upper aquifer of 4.0 x 10^{-3} cm/sec, which is consistent with the results of the pumping test. The hydraulic conductivity and specific yield were used in conducting the modelling of the extraction systems.

Groundwater Model. A groundwater model for the site was developed during the RI/FS to aid in the evaluation of the groundwater flow system and to assess various remedial actions. The U.S.G.S. MODFLOW model was implemented, using available site specific data, including aquifer properties developed from the RI aquifer tests, and water level and precipitation data.

The model was used to assist in estimating the probable yield of the PGCS. Visual Modflow (Vmodflow) was used for the modeling, because it uses the same U.S.G.S. Modflow model used in the RI/FS and adds the capability of using the U.S.G.S. Model, Modpath. Modpath is a particle tracking post-processing package that was developed by U.S.G.S to compute three-dimensional path lines based from Modflow output. By using Vmodflow and Modpath, the Modflow output could be used to evaluate the effectiveness of various potential groundwater extraction systems.

Modeling was conducted iteratively, using the flow model component followed by the flow path model and then returning to the flow model. Several different extraction trench alignments were evaluated to assess locations and target drawdowns to provide optimal capture of the flow in the upper aquifer between the ACS facility and the wetlands to the north and west. The results of the modeling were used in designing the extraction trench for the PGCS and the dewatering system for the ONCA.

Since subsurface barrier walls will be installed around the OFCA and SBP, flows from these areas were estimated by calculating the volume of water to be removed and dividing by the desired dewatering period. The volume of water to be removed was assumed to be equal to the volume of the saturated zone (above the silty clay) within the area to be dewatered multiplied by an assumed porosity (0.3 for the OFCA and 0.4 for the SBP). As the water table is drawn down to the desired level, the flow will decrease. Once the water table has been lowered, the flow will be equal to the amount of infiltration into the area. Data suggest that some upward flow may exist in this area through the silty clay, but for the purposes of the dewatering calculations it has not been included. For the design, it was assumed that the dewatering of the two areas would be accomplished concurrently over a five year period.

The flow contributions from the small areas within the SBP and OFCA which will be dewatered for pilot testing are unknown at this time. The current plan is to install temporary sheet pile or other type of barrier walls to minimize the volume of water to be extracted. Since these test areas will be located in the most contaminated portions of the site, the extracted groundwater will have high concentrations of contaminants. If possible, the water will be stored in tanks and gradually bled into the treatment system influent. If this approach is not feasible, the water will be properly disposed of at a permitted off-site facility.

Since there are several sources of water, nearly all of which have high flows for a short initial period and then lower flows once steady-state conditions are reached, it is essential to develop a schedule for staggering the activities such that the most appropriate treatment system can designed to meet the project's needs. This approach will avoid the need to design and construct a treatment system to accomodate short duration or limited flows. A schedule for staggering the startup and operation of each of the water-producing activities and the resulting estimated flows to the treatment system is presented in Table 2-1. The schedule is based on the following strategy:

Stage 1: Startup the PGCS (the extraction trench) at an initial flowrate of approximately 40 to 45 gallons per minute (gpm).

Stage 2: As the extraction trench system reaches steady-state, the flow will decrease. After six months of operation, the flow should be approximately 15 gpm. At this time, the dewatering for the SVE pilot study in the ONCA can begin. Theinitial flow from this system is estimated to be 18 gpm. Total flow to the treatment system from these two sources will be 33 gpm.

TABLE 2-1

ESTIMATED FLOWS AND SCHEDULING TO TREATMENT SYSTEM

Stage	Cumulative Operating Time	Flow PGCS (gpm)	ONCA (gpm)	OFCA (gpm)	SBP (gpm)	Total (gpm)
1	startup	42	0	0	0	42
2	6 months	15	18	0	0	33
3	1 year	12	5	8	5	30
4	2 years	12	30	8	5	55
5	8 to 10 years	12	0	5	3	20

Stage 3: After one year of operation, flow from the extraction trench should have reached steady-state which is estimated to be about 12 gpm. Similarly, flow from the ONCA pilot dewatering system should be at a steady-state flow of 5 gpm. It is also anticipated that the subsurface barrier walls for the SBP and OFCA will have been installed by this time and the dewatering wells can be turned on. The dewatering wells will be operated to dewater the areas over a period of five years. The flows are estimated to be 8 gpm from the OFCA and 5 gpm from the SBP. The total combined flow to the treatment system from all sources will be 30 gpm.

Stage 4: After two years of operation, the extraction trench will still be pumping at 12 gpm. By this time, sufficient data will have been collected from the ONCA SVE pilot study to finalize the full-scale design. The first step in implementing the full-scale SVE system will be to increase the extent of the area to be dewatered. The increased flow from this activity is estimated to be 30 gpm. Flows from the OFCA and SBP gradient control wells will still be at 8 gpm and 5 gpm, respectively. Total combined flow to the treatment system will be 55 gpm.

Stage 5: After 8 to 10 years of operation, it is anticipated the extraction trench will still be pumping at 12 gpm and the OFCA and SBP dewatering wells will still be at their estimated maintenance flows of 5 gpm and 3 gpm, respectively. The SVE in the ONCA will have been completed and the dewatering system will be shut down. Total combined flow to the treatment plant will be 20 gpm.

2.1.3. Design Hydraulic Capacity

Based on the estimated flows presented in Table 2-1, the treatment system will be sized for a maximum hydraulic capacity of 60 gpm. A design flow rate of 60 gpm provides more than enough capacity to treat the flows expected during the dewatering of the ONCA for the full-scale SVE (Stage 4). The long term flow to the system will be 20 gpm (Stage 5) based on steady-state pumping from the perimeter extraction trench and maintenance flows from the OFCA and SBP. A flow rate of 20 gpm will be the design minimum flow rate and the flexibility to turn-down the treatment system to handle this flow will be incorporated into the initial design. More detailed information on the hydraulic capacity of each unit process is provided later in this document.

2.1.4. Design Influent Concentrations

The characteristics of the groundwater from each of the areas were projected based on samples from either groundwater monitoring wells (PGCS and ONCA) or Geoprobes (SBP and OFCA). The projected characteristics are based on the average value of samples from each area. The information collected in the sampling program has since been supplemented with the results of the recent sampling and analysis that was performed in June 1995 as part of bench scale testing of advanced oxidation equipment. The recent sampling activity involved collecting groundwater samples from the existing pump test well and collecting Geoprobe groundwater samples from the SBP and OFCA. The characteristics of the source streams are presented in Table 2-2.

To design the treatment system, an influent profile was developed for each of the flow conditions (Stages 1 through 5) shown previously in Table 2-1. As expected, the high concentrations of contaminants in the SBP and OFCA significantly impact the quality of the influent. In fact, the high contaminant levels in these areas greatly impact the selection and sizing of the treatment processes even when all groundwater streams are combined. There is, however, substantial uncertainty about whether or not the water quality data for these two areas are representative of what will actually be extracted from the planned dewatering systems. The uncertainty revolves around the following concerns:

- The data used to characterize groundwater from these two sources are from samples collected using the Geoprobe method. Samples collected using properly installed and developed dewatering wells will likely have lower levels of solids, non-aqueous phase liquids, and other contaminants.

- The Geoprobe samples were taken in the more contaminated portions of the SBP and OFCA. The dewatering wells could be placed in less contaminated areas, therefore reducing the levels of contamination in the extracted groundwater.

TABLE 2-2

PROJECTED INFLUENT CHARACTERISTICS

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Water Quality							
pH	Std Unit	6.7	6.7	6.45	6.30	6.32	5.81
Dissolved oxygen	mg/l	6.5	6.5	7.4	6.1		
Temperature	degree C	11.4	11.4	14.5	10.83		
Specific conductance	µmHos/cm	965	965	4,360	1,250		
Hardness, total	mg/l-CaCO3	670	670	1,366	688		
Residue, diss (TDS)	mg/l	853	853	6,410	1,328		
Residue, susp (TSS)	mg/l	125	125	967	25,367	12,400	391
Alkalinity, total	mg/l-CaCO3	455	455	1,913	473		
BOD	mg/l	16	16	36,533	2,420	8,370	14,700
COD	mg/l	111	111	139,567	4,090	79,500	26,000
Carbon (TOC)	mg/l	28	28	94,950	1,237		
Oil and grease (e)	mg/l	1.0	1.0	101,683	784	30,200	74

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 2-2

PROJECTED INFLUENT CHARACTERISTICS (CONTINUED)

Constituents	Units	PGCS[(a)]	ONCA[(b)]	OFCA[(c)]	SBP[(d)]	50/50 SBP/OFCA Unsettled[(e, g)]	50/50 SBP/OFCA Settled[(f, g)]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Anions							
Chloride	mg/l	28	28	996	146		
Nitrogen, TKN	mg/l as N	9.2	9.2	234	27.07		
Phosphorus, total	mg/l as P	0.1	0.1	1.00	2.22		
Sulfate	mg/l	268	268	336	110		
Cations							
Antimony	mg/l	0.002	0.002	0.094	0.014		
Arsenic	mg/l	0.025	0.011	0.026	0.018	0.046	0.028
Cadmium	mg/l	0.010	0.010	0.61	0.06	0.96	0.543
Calcium	mg/l	188	188	274	138		
Chromium, total	mg/l	0.010	0.010	1.19	0.037	2.23	0.05
Copper	mg/l	0.020	0.020	0.26	0.24	5.61	0.27
Iron	mg/l	15.0	15.0	1,527	246	489	386
Lead	mg/l	0.007	0.007	2.43	0.176	9.61	0.105

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 2-2

PROJECTED INFLUENT CHARACTERISTICS (CONTINUED)

Constituents	**Units**	**PGCS[(a)]**	**ONCA[(b)]**	**OFCA[(c)]**	**SBP[(d)]**	**50/50 SBP/OFCA Unsettled[(e, g)]**	**50/50 SBP/OFCA Settled[(f, g)]**
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Cations (continued)							
Magnesium	mg/l	35	35	67.7	63.7		
Manganese	mg/l	0.960	2.380	NA	NA		
Mercury	mg/l	0.000	0.000	0.0025	0.0026		
Nickel	mg/l	0.020	0.020	0.54	0.097	2.09	0.78
Potassium	mg/l	6.2	6.2	31.01	11.43		
Selenium	mg/l	0.002	0.002	0.002	0.003		
Sodium	mg/l	NA	NA	604.8	38.8		
Thallium	mg/l	0.001	0.002	0.002	0.002		
Zinc	mg/l	0.063	0.063	164	1.39	33.1	19.0
Organics							
Acetone	µg/l	30	10	7,700	7,700	1,710,000	241,000
Benzene	µg/l	9,250	320	96,000	9,350	9,640,000	7,150
bis(2-Chloroethyl)ether	µg/l	50	10	340	803		

((a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.

(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.

(c) OFCA – Average value from three geoprobe samples.

(d) SBP – Average value from three geoprobe samples.

(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.

(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.

(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 2-2

PROJECTED INFLUENT CHARACTERISTICS (CONTINUED)

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Organics (continued)							
bis(2-Ethylhexyl)phthalate	µg/l	10	10	11,037	2,213	320,000	120
2-Butanone	µg/l	10	10	15,000	15,000	974,000	272,000
Butyl benzyl phthalate	µg/l	10	10	10	40	27,000	10
Chloroethane	µg/l	750	700	3,100	3,100	1	230
Chloromethane	µg/l	2.5	2.5	2	2	<0.028	1,940
4-Chloro-3-methylphenol	µg/l	10	10	10	10		
1,2-Dichlorobenzene	µg/l	20	3	1	1	569,000	10
Diethyl phthalate	µg/l	10	10	10	97	<25,000	40
2,4-Dimethylphenol	µg/l	10	15	3,870	267		
Dimethyl phthalate	µg/l	10	10	267	10	<25,000	380
Di-n-butyl phthalate	µg/l	10	10	10	97	65,000	10
Ethylbenzene	µg/l	250	3	188,700	78,467	6,200,000	664
Isophorone	µg/l	10	10	20,833	740	77,000	10

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 2-2

PROJECTED INFLUENT CHARACTERISTICS (CONTINUED)

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Organics (continued)							
Methylene Chloride	µg/l	50	50	56,668	6,002	936,000	22,000
4-Methyl-2-pentanone	µg/l	10	40	14,000	14,000	2,900,000	29,600
4-Methylphenol	µg/l	10	10	560	560		
Naphthalene	µg/l	2	10	21,740	3,543	2,410,000	38
Phenol	µg/l	10	10	16,670	417		
Tetrachloroethene	µg/l	1.5	10	25,667	3,267	35,200,000	2,450
Tetrahydrofuran	µg/l	10	4,000	10	10		
Toluene	µg/l	300	300	27,064,000	336,000	31,400,000	22,600
1,1,1-Trichloroethane	µg/l					14,600,000	16,500
Trichloroethene	µg/l	10	1.5	23,067	4,667	7,650,000	3,670
Trichlorofluoromethane	µg/l	3	3	1	1	128,000	34
Vinyl chloride	µg/l	120	120	1	1	25,800	80
Xylenes, total	µg/l	5	5	1,011,000	395,000	35,000,000	1,400

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

- Given the heterogeneous nature of the materials disposed in the SBP and the OFCA, it is very difficult to obtain a representative sample.

Because of the uncertainty associated with treating groundwater from the SBP and OFCA, the following decisions were made:

- At a minimum, provide a phase separator for pretreatment of groundwater from the SBP and OFCA.

- When sizing the main treatment components, assume that the groundwater extracted from the SBP and OFCA naturally has "lower" levels of contaminants than the available data indicate. This is likely to be the case because the extracted groundwater will be a mixture of highly contaminated groundwater (represented by Geoprobe data) and groundwater from less contaminated areas. If this does not prove to be the case, then we will install additional pretreatment facilities to reduce the levels in these two streams before blending with the PGCS and ONCA streams. The "lower" levels of contaminants in the SBP and OFCA were estimated using the data from the settled sample in Table 2-2 and applying a 95 percent reduction for each constituent. The data from the settled sample is representative of the effluent from a phase separator and the 95 percent reduction should be representative of the effluent from a pretreatment process. The resulting concentrations will be used for the SBP and OFCA groundwaters when developing a flow-weighted average influent to the main treatment processes.

- Provide extra space to allow for the additional pretreatment facilities. The determination as to the need for the additional pretreatment facilities will be made after data are collected on the actual water extracted from the dewatering wells.

This approach offers the best potential for a flexible, and if necessary, expandable groundwater treatment system. By providing some capacity to handle the dewatering water, it affords the opportunity to startup the dewatering systems and collect data to characterize the actual water from the SBP and OFCA. If the contaminant levels are as high as the Geoprobe data indicate, flow from the dewatering systems would be minimized or shutdown while the additional necessary pretreatment facilities were installed. If, on the other hand, the contaminant levels are much lower, additional treatment facilities may not be needed, and it may be possible to pump the dewatering systems at a higher flowrate.

Using the above assumptions, influent profiles were developed and are shown in Table 2-3 for the following conditions: (1) the combined SBP and OFCA groundwaters, (2) the stage 4 flow condition which represents the worst case contaminant loading (referred to as the design condition in Table 2-3), and (3) the stage 5 (long-term) flow condition.

2.1.5. Effluent Quality Criteria

In accordance with the ROD, effluent from the treatment system will be discharged to the adjacent wetlands. Although a discharge permit is not required (see Section 3), the substantive requirements of a permit, such as effluent standards, need to be met. For discharges to the wetlands at the ACS Site, IDEM has issued the effluent limits presented in Table 2-4.

2.1.6. Residuals Management

Residual solids generated by the PGCS treatment facility may be subject to the hazardous waste disposal regulations, if classified as a hazardous waste. Sludge produced at the facility will be characterized using the Toxicity Characteristics Leaching Procedure (TCLP) to determine its status as a hazardous waste. If solids are determined to be nonhazardous, they will be disposed by landfilling in an approved facility after securing the necessary disposal permits. If the residuals are found to be hazardous they will be disposed in an approved hazardous waste disposal facility using a hazardous waste disposal contractor.

Nonaqueous phase liquid (NAPL) will be handled similarly to the sludge. Based on screening analysis results of the NAPL, the NAPL reclaimer will determine the ultimate disposal method.

TABLE 2-3

DESIGN INFLUENT CONCENTRATIONS

Constituents	Units	SBP/OFCA Groundwater[a]	Combined Groundwaters: Design Condition[b]	Combined Groundwaters: Long-Term Condition[c]
Flow	gpm	13	55	20
Water Quality				
pH	Std Unit	6.4	6.6	6.5
Dissolved oxygen	mg/l	0	0	0
Temperature	degree C	12	16	19
Specific conductance	μmHos/cm	3,164	1,470	1,819
Hardness, total	mg/l-CaCO3	1,105	772	842
Residue, diss (TDS)	mg/l	4,455	651	512
Residue, susp (TSS)	mg/l	1,000	152	171
Alkalinity, total	mg/l-CaCO3	1,359	667	813
BOD	mg/l	23,413	189	310
COD	mg/l	87,460	416	627
Carbon (TOC)	mg/l	58,907	104	157
Oil and grease	mg/l	30,000	1.9	2.6
Anions				
Chloride	mg/l	670	258	417
Nitrogen, TKN	mg/l as N	155	42	66
Phosphorus, total	mg/l as P	1.5	0.5	0.7
Sulfate	mg/l	250	263	261
Cations				
Antimony	mg/l	0.090	0.023	0.037
Arsenic	mg/l	0.030	0.019	0.027
Cadmium	mg/l	0.540	0.135	0.222
Calcium	mg/l	220	195	201
Chromium, total	mg/l	0.750	0.019	0.026
Copper	mg/l	0.300	0.086	0.132
Iron	mg/l	1,034	106	169
Lead	mg/l	1.500	0.029	0.044
Magnesium	mg/l	70	43	49
Manganese	mg/l	NA	NA	NA

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

TABLE 2-3

DESIGN INFLUENT CONCENTRATIONS (CONTINUED)

Constituents	Units	SBP/OFCA Groundwater[(a)]	Combined Groundwater: Design Condition[(b)]	Combined Groundwater: Long-Term Condition[(c)]
Cations (continued)				
Mercury	mg/l	0.0025	0.0007	0.0011
Nickel	mg/l	0.800	0.204	0.332
Potassium	mg/l	25	11	14
Selenium	mg/l	0.002	0.002	0.002
Sodium	mg/l	NA	NA	NA
Thallium	mg/l	0.0020	0.0019	0.0014
Zinc	mg/l	100	4.8	8.0
Organics				
Acetone	µg/l	125,000	1,489	2,518
Benzene	µg/l	63,000	2,311	5,750
bis(2-Chloroethyl)ether	µg/l	500	22.3	40.0
bis(2-Ethylhexyl)phthalate	µg/l	8,000	13.5	16.0
2-Butanone	µg/l	150,000	1,780	3,006
Butyl benzyl phthalate	µg/l	20.0	7.8	6.2
Chloroethane	µg/l	3,100	548	455
Chloromethane	µg/l	2,000	25.5	41.5
4-Chloro-3-methylphenol	µg/l	10.0	7.8	6.2
1,2-Dichlorobenzene	µg/l	10,000	124	212
1,1-Dichloroethane	µg/l	25,000	448	620
1,2-Dichloroethane	µg/l	66,000	78.5	126
1,1-Dichloroethene	µg/l	80.0	2.5	2.8
1,2-Dichloroethene-cis	µg/l	75,000	1,317	2,010
1,2-Dichloroethene-trans	µg/l	20.0	27.0	21.4
1,2-Dichloropropane	µg/l	300	4.7	6.9
Diethyl phthalate	µg/l	40.0	8.1	6.8
2,4-Dimethylphenol	µg/l	2,500	34.0	46.0
Dimethyl phthalate	µg/l	400	12.4	14.0
Di-n-butyl phthalate	µg/l	100	8.8	8.0
Ethylbenzene	µg/l	146,000	174	350

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SDP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

TABLE 2-3

DESIGN INFLUENT CONCENTRATIONS (CONTINUED)

Constituents	Units	SBP/OFCA Groundwater[(a)]	Combined Groundwater: Design Condition[(b)]	Combined Groundwater: Long-Term Condition[(c)]
Organics (continued)				
Isophorone	µg/l	13,000	7.8	6.2
Methylene Chloride	µg/l	37,000	298	470
4-Methyl-2-pentanone	µg/l	30,000	379	606
4-Methylphenol	µg/l	560	13.5	16.0
Naphthalene	µg/l	15,000	11.8	11.2
Phenol	µg/l	10,500	126	206
Tetrachloroethene	µg/l	17,000	35.3	50.9
Tetrahydrofuran	µg/l	10.0	2,184	6.2
Toluene	µg/l	16,784,000	525	680
1,1,1-Trichloroethane	µg/l	17,000	203	346
Trichloroethene	µg/l	16,000	50.3	86.0
Trichlorofluoromethane	µg/l	30.0	2.6	2.4
Vinyl chloride	µg/l	80.0	92.6	73.6
Xylenes, total	µg/l	775,000	27.5	43.0

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SDP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

TABLE 2-4

EFFLUENT LIMITATIONS FOR DISCHARGE TO WETLANDS

Constituent	Units	Effluent Limitation
General Water Quality Parameters		
BOD5	mg/l	30
TSS	mg/l	30
pH	s.u.	6 to 9
Inorganics		
Arsenic	µg/l	50
Cadmium	µg/l	4.1
Mercury	µg/l	0.02 w/DL=0.64[a]
Selenium	µg/l	8.2
Zinc	µg/l	411
Volatile Organics		
Benzene	µg/l	5
1,2-Dichloroethene-cis	µg/l	70
Ethylbenzene	µg/l	34
Methylene chloride	µg/l	5
Tetrachloroethene	µg/l	5
Trichloroethene	µg/l	5
Vinyl chloride	µg/l	2
Semi-Volatile Organics		
Acetone	µg/l	6,800
bis(2-Chloroethyl)ether	µg/l	9.6
bis(2-Ethylhexyl)phthalate	µg/l	6
2-Butanone	µg/l	210
Isophorone	µg/l	50
4-Methyl-2-pentanone	µg/l	15
4-Methylphenol	µg/l	34
Pentachlorophenol	µg/l	1
PCBs		
PCBs	µg/l	0.00056 w/DL=0.1[a]

(a) Concentration shown is the effluent limitation, but analytical results showing less than the detection limit shown will be considered as in compliance.

2.2 MAJOR TREATMENT PROCESSES

Based on the influent profiles, the suite of contaminants requiring removal from the groundwater prior to discharge varies considerably depending on which flow condition is selected. The major constituents in the PGCS and ONCA groundwater include iron (needs to be removed for process reasons), cadmium, and a limited number of aromatic and chlorinated solvents such as benzene, ethylbenzene, tetrachloroethene, trichloroethene, vinyl chloride, bis(2-chloroethyl)ether, and bis(2-ethylhexyl)phthalate that are present at low concentrations. The major contaminants in the high-strength SBP and OFCA groundwaters include TSS, COD, BOD, TOC, nonaqueous phase liquids (NAPL), iron and other metals as well as wide variety of individual volatile and semivolatile organic compounds as listed in Tables 2-2 and 2-3. Based on an evaluation of applicable treatment processes, a multi-process treatment train was selected for implementation at the site. The selected treatment train incorporates the necessary facilities to reduce all of the constituents to the appropriate discharge levels. Given the uncertainty regarding the levels of contaminants in the SBP and OFCA, however, it is recommended that some of the components not be installed at this time. Once data are available on the actual water extracted from the dewatering system, a determination can be made regarding the need for and appropriate sizing of these components. For completeness, these components are discussed in the following text, but they are labeled as "future" facilities and the text describing them is highlighted by italics . It should be noted that the selection of future facilities is contingent upon future information that will be collected on the quality and treatability of the source water. Therefore, the actual future facilities that may be installed could be different from the facilities described in this document.

Reduction of Non-Aqueous Phase Liquids (NAPLs). The treatment system will incorporate pretreatment of the high-strength groundwaters for removal of free phase organic constituents prior to blending with the lower strength PGCS and ONCA groundwater. A phase separation unit will be used for removal of NAPLs. Further removal of dissolved organic material (not removed by phase separation) will occur during treatment in the subsequent UV oxidation system and carbon adsorption units.

Reduction of Suspended Solids. Initial removal of suspended solids will occur in the phase separator. Solids will be further removed via entrapment by floc in a metals precipitation process which will be followed by sedimentation and filtration.

Reduction of Iron and Other Metals. Dissolved iron will be oxidized in a UV oxidation process and the resulting precipitate will be removed in the chemical precipitation process. Other heavy metals will also be precipitated in the chemical precipitation process which will be followed by sedimentation and filtration.

Reduction of Dissolved Volatile and Semi-Volatile Organic Compounds. Dissolved organics will be destroyed using a UV-peroxide oxidation process. Carbon adsorption columns will be provided for effluent polishing and they will be used on an as-needed basis. If necessary in the future, a pretreatment system will be added to reduce dissolved organic material in the high-strength groundwaters from the site. Following pretreatment, the high-strength groundwater will be blended with the low-strength groundwater and the residual organic constituents will be removed in the UV oxidation system.

Reduction of COD, BOD, and TOC. Reduction of COD, BOD and TOC will occur along with the reduction of NAPLs, suspended solids and organic constituents using the processes described above.

The system that will be installed initially will contain all of the equipment necessary to treat the maximum flow rate (60 gpm) with the organic, metals and suspended solids concentrations listed for the "design condition" combined influent (Table 2-3). The initial equipment to be installed also includes phase separation and oil storage tanks for up to 13 gpm from the SBP and OFCA. Additional space will be provided, and piping will be installed so that additional pretreatment equipment can easily be installed. Space will also be provided for an additional phase separator for treatment of high-strength influent should additional phase separation capacity be needed in the future.

2.3 PRETREATMENT FACILITIES

2.3.1. Phase Separator

Prior to being conveyed to the main treatment system, the high-strength groundwater from the OFCA and SBP will be pretreated in a phase separator to remove free phase materials (i.e., organic constituents that are present above their solubility limit). Some of the heavier suspended solids will be removed as well. Geoprobe samples from both areas have contained significant amounts of free phase material, and in bench scale testing, this material has been shown to be readily separable. The low-strength groundwater from the PGCS and ONCA also has the potential for having trace amounts of free phase material, and therefore, the necessary piping will be provided to route this stream through the phase separator as well.

Process Description. Separation of solids and free phase material will be accomplished using a gravity separator with coalescing plates to aid in phase separation. The recovered NAPL and other organic phase material will be skimmed from the top of the tank and will flow by gravity to an oil storage tank located below the separation unit. Solids which settle out in the separator will be pumped to a sludge storage tank for thickening prior to either off-site disposal or dewatering in a filter press.

Design Criteria. The key design criteria for the NAPL separation units and associated storage tanks are shown in Table 2-5.

Major Components. The major components of the NAPL separation system are listed in Table 2-6.

System Operation and Control. The primary function of the phase separation system is to remove free phase material and suspended solids in the groundwater from the high-strength source areas (OFCA and SBP). All liquids from these areas will be combined and conveyed to the phase separator which will be located on an elevated platform in the treatment system building. The dewatering well pumps will pump the groundwater directly into the separator. Effluent from the separator will flow by gravity to an equalization tank before being pumped to downstream treatment processes. Free phase material collected by the separator will flow by gravity to a storage tank located directly below the phase separator platform. There will be no control of either effluent or free phase material flow from the separator other than manual open/close valves on the influent and effluent lines. The valves will normally be in the open position to allow free flow of both liquids from the separator. Solids that settle out in the separator will collect in a hopper and will be pumped on an intermittent basis to a sludge storage and thickening tank. The sludge pump will operate off of a sludge interface level probe and/or a timer. The sludge storage tank will be equipped with multiple decant ports which will discharge to a filtrate, decant water, backwash sump. The decant discharge line will be provided with a sight glass so that the plant operator can assess the quality of the liquid withdrawn. Sludge from the storage tank will be either dewatered using a filter

TABLE 2-5

DESIGN CRITERIA FOR PRETREATMENT SYSTEM

Component	Parameter	Design Criteria
Phase Separator	Number	1 initial, *1 future*
	Capacity (max.) Capacity (avg.)	20 gpm (each) 13 gpm (each)
	Hydraulic Ret. Time Overflow Rate (max.)	40 min. @ 20 gpm 1,000 gpd/sf
Phase Sep. Solids Pump	Number Type Max. Flowrate	1 initial, *1 future* Air Diaphragm 125 gpm
NAPLStorage Tank	Number	1
	Capacity	6,500 gal. 9 days storage $[NAPL]_{inf.}$ water=30,000 mg/l $[NAPL]_{eff.}$ water=75 mg/l NAPL s.g. = 0.8
Solids Storage Tank	*Number*	*1 future*
	Capacity	*6,500 gal.* *9 days storage* *$[solids]_{inf.}$ water=1,000 mg/l* *$[solids]_{eff.}$ water=240 mg/l* *[Solids] in tank=1.0%*
Solids Pump	*Number*	*1 future*
	Type	*Air Diaphragm*
	Max. Flowrate	*125 gpm*
Pretreatment Equalization Tank	Number	1
	Capacity	3,000 gal 3.8 hrs HRT @ 13 gpm
Pretreatment UV Oxid. System	*Number*	*1 future*
	Capacity (max.) *Capacity (min.)*	*30 gpm* *10 gpm* *1,000 gal recirculation tank*

TABLE 2-5

DESIGN CRITERIA FOR PRETREATMENT SYSTEM (CONTINUED)

Component	Parameter	Design Criteria
Pretreatment UV Oxid. System (continued)	*Number*	*1 future*
	Removal Efficiency	*90 % for COD, TOC and BOD* *95 % specific organic compounds*
Steam Boiler	*Number*	*1 future*
	Capacity	*680,000 BTUs/hr*

TABLE 2-6

PRETREATMENT SYSTEM COMPONENTS

Component	Quantity	Description
Phase Separator	2 (1 initial, 1 *future*)	Coalescing Plate Separator 4.3'W x 6.7'L x 4'H Total Volume=800 gal. Stainless Steel
NAPLStorage Tank	1	6,500 gal. 10' dia x 12' SWD Stainless Steel
Solids Storage Tank	*1 future*	*6,500 gal.* *9' dia x 19' SWD, conical bottom* *Stainless Steel*
Solids Pumps	2 (1 initial, 1 *future*)	Air Diaphragm Pumps 1.5" Connections 125 gpm max. flowrate Kynar Body, Viton/Teflon Diaphragm Teflon Ball Valves
Equalization Tank	1	3,000 gal 8' dia x 9' SWD Stainless steel
	1	Tank Mixer 1 hp 68 rpm dual propeller
Pretreatment Pumps	2	15 gpm each Horizontal Centrifugal Stainless Steel
Oxidation System	*1 future*	*30 kW Stainless Steel Reactor with 1" inf. and effl. flanges, Power Supply, and PLC*
	1 future	*1,000 gal. Recirculation Tank* *Stainless Steel*
	2 future	*Heat Exchangers, 1 steam, 1 effluent cooling/ influent preheating*
	1 future	*Acid Delivery System*
	1 future	*Peroxide Delivery System*
Steam Boiler	*1 future*	*Steam Boiler* *Natural Gas Fired*
Process Piping	NA	All Connecting Piping 316 Stainless Steel

press, or removed periodically (as a liquid) by a truck and transported off-site for disposal. Foul air will be collected from the separator, oil storage tank, and sludge storage tank, and vented through a vapor phase carbon canister.

2.3.2. UV Oxidation System (Future)

If the contaminant levels in groundwater from the OFCA and SBP are as high as the preliminary Geoprobe data indicate, these two source streams will need to be pretreated to reduce the levels of dissolved organic constituents prior to being mixed with low-strength waters from the PGCS and ONCA. Based on preliminary testing, an advanced oxidation unit (following phase separation) may be the most cost-effective process to accomplish the pretreatment. It is advantageous to pretreat the high-strength water in a separate UV oxidation process prior to diluting with the low-strength water because the oxidation process is more efficient at removing high concentrations of organic material from low flow rates than removing low to medium concentrations of material from high flow rates as would occur if the high-strength and low-strength groundwaters were mixed initially.

Process Description. *Oxidation of the organic material and reduced iron in the influent groundwater will be accomplished by heating the influent stream to approximately 130° F and injecting sulfuric acid and hydrogen peroxide. The water will then pass through a reactor containing high intensity ultraviolet lamps. The UV light and reduced iron in the water will catalyze the decomposition of the peroxide into highly reactive hydroxyl radicals which will subsequently attack and destroy dissolved organic material. Some decomposition of organic material will also result from the direct effect of UV light. The reduced iron in the influent groundwater will also be oxidized by the peroxide in the process and will form an insoluble precipitate upon adjustment of the pH following the reaction.*

Design Criteria. *The key design criteria for the advanced oxidation unit and associated equipment are shown in Table 2-5.*

Major Components. *The major components of the oxidation system are listed in Table 2-6. The pretreatment UV oxidation system and steam boiler will not be installed in the initial phase of construction of the overall treatment system. The associated* *chemical storage tanks; influent equalization tank and feed pumps will, however be installed initially.*

System Operation and Control. *The primary function of the oxidation system is to reduce the concentration of dissolved organic material in the high-strength source streams prior to blending with low-strength waters. All liquids from the high-strength areas will be combined, passed through the phase separator and will then flow into the pretreatment equalization tank prior to being pumped through the oxidation system. The system will be designed to have the flexibility to operate as either a once-through system or as a recirculating batch system. With once-through operation, water will be pumped from the pretreatment equalization tank through a heat exchanger and UV reactor and into the main equalization tank where it will be mixed with low-strength groundwater. In the recirculating batch treatment mode, water will be pumped into a small batch treatment tank. Water in the batch treatment tank will be recirculated through the heat exchanger and UV reactor until the desired level of organic constituent removal is achieved, at which point the water will be pumped to the main treatment system equalization tank. The batch treatment will then be started again with a fresh batch of water.*

Effluent from the oxidation process will flow to the main treatment system equalization tank before being pumped to downstream treatment processes. The system operation will be controlled by a programmable logic controller (PLC) provided by the equipment vendor. The PLC will control the operation of the feed pumps based on the level in the equalization tank, control the batch treatment cycle if the system is operated in batch mode, control the chemical feed systems based on flow (peroxide dosing) and pH (acid addition), and will control the UV light intensity based on flow. Bulk peroxide and sulfuric acid storage tanks will be provided. The chemical storage systems are described later in the section on the main treatment system.

2.4 MAIN TREATMENT FACILITIES

The main treatment system contains the facilities necessary to provide for flow equalization, organics removal, metals removal, solids removal, and solids handling. A conceptual process flow diagram showing the main treatment units is shown in Figure 2-1. Low-strength groundwater from the PGCS and ONCA will be pumped directly to the main influent equalization tank where it will be blended with effluent from

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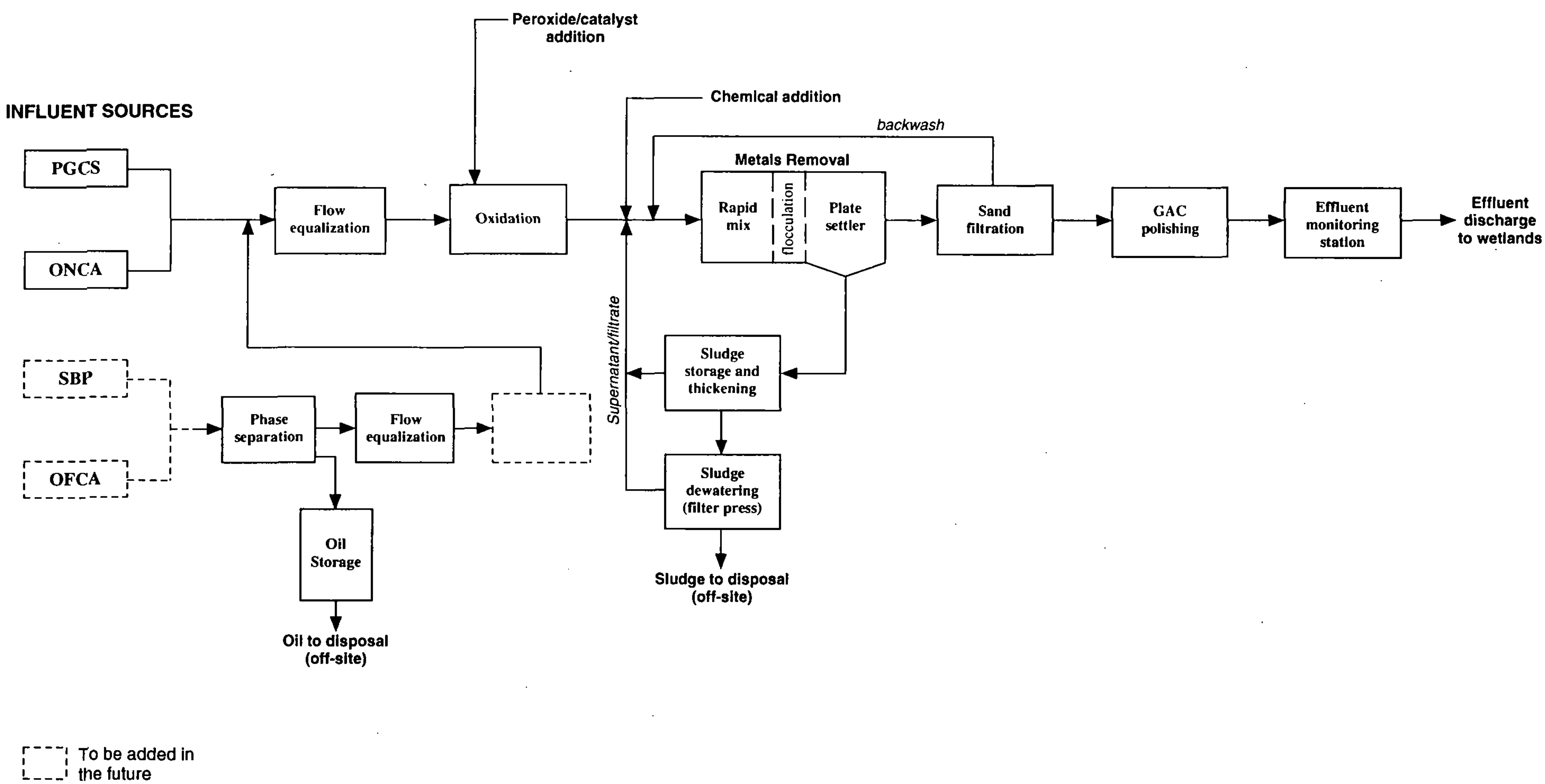


MONTGOMERY WATSON

AMERICAN CHEMICAL SERVICES, INC.
NPL SITE, GRIFFITH, INDIANA
PROCESS FLOW DIAGRAM OF GROUND-WATER TREATMENT SYSTEM
FIGURE 2-1

the high-strength groundwater pretreatment system. The groundwater will then be pumped to an UV oxidation system which will remove dissolved organic contaminants. Effluent from the oxidation system will flow to a metals removal system consisting of precipitation, flocculation and settling. Effluent from metals removal system will flow through a sand filter for removal of residual suspended solids. If needed, the flow will be pumped through granular activated carbon adsorption vessels to remove specific organic compounds prior to discharge. A sludge storage and dewatering system will be provided. The process units and their functions are described in the following section.

2.4.1. Process Description

The main treatment process combines several different physical-chemical processes to remove both organic and inorganic components of the groundwater. The system consists of five main treatment processes; advanced oxidation; chemical precipitation, sedimentation, filtration and carbon adsorption as well as influent equalization and pH adjustment. Each of the individual process units is described in this section. A more detailed process flow diagram and process and instrumentation diagram is provided as part of this submittal to show the relationship between the various unit processes and their control mechanisms.

Influent Storage and Equalization. To provide sufficient blending and equalization of the influent streams, 80 minutes of equalization capacity at a flow rate of 60 gpm will be provided. The equalization tank will receive low-strength groundwater directly from the PGCS and ONCA and pretreated effluent from the high-strength groundwater pretreatment system. The tank will be supplied with a mixer to blend the two groundwaters and will function as a wetwell for the influent feed pumps for the main treatment processes.

Main UV Oxidation System. The UV oxidation system provides destruction of the organic components in the groundwater by oxidation of the organic carbon to carbon dioxide and innocuous byproducts such as simple dibasic acids. Halogens such as chloro and bromo substituents are converted to salts. The system uses hydrogen peroxide as the main source of oxidizing potential. Both high intensity UV light and reduced iron salts are used as catalysts. The main oxidizing species created by the process are hydroxyl radicals which form from the decomposition of peroxide by the two catalysts. Oxidation of the organic material and reduced iron in the influent stream will be accomplished by injecting sulfuric acid and hydrogen peroxide. The water will then pass through a reactor containing high intensity ultraviolet lamps. The UV light and reduced iron in the water will catalyze the decomposition of the peroxide into hydroxyl radicals which subsequently attack and destroy dissolved organic material. Ferrous sulfate will also be injected if an additional source of iron is needed, however its use on a regular basis is unlikely because of the relatively high reduced iron content of the groundwater at the site. Some decomposition of organic material will also result from the direct effect of UV light and peroxide which are also oxidizing agents, although they are less powerful than hydroxyl radicals. The reduced iron will also be oxidized in the process and will form an insoluble precipitate upon adjustment of the pH following the reaction.

Effluent from the oxidation process will flow to the metals removal system for removal of iron, and other metals. Suspended solids will also be removed in the metals removal system. The oxidation system will be controlled by a programmable logic controller (PLC) provided by the equipment vendor. The PLC will control the chemical feed systems based on flow (peroxide and ferrous sulfate dosing) and pH (acid addition), and will control the UV light intensity based on flow. Peroxide, sulfuric acid and ferrous sulfate will be added using chemical metering pumps to precisely control the dosages. Bulk storage tanks will be provided for 50 percent peroxide solution and 93 percent sulfuric acid. Ferrous sulfate, if needed, will be fed from 55-gallon drums.

Metals Removal System. Oxidized iron, other metals such as cadmium, selenium, mercury and zinc, and suspended solids in the effluent from the oxidation system will be removed in a chemical precipitation unit. The unit will consist of a rapid mix tank in which the pH will be raised to the desired level (approximately 10 s.u.), a flocculation tank, and a plate settler (Lamella clarifier) with an internal sludge thickener. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustments. The acid feed system will utilize the bulk storage tank previously described as part of the oxidation systems. A bulk storage tank will also be provided for 50 percent sodium hydroxide solution. Liquid polymer will be used to aid in coagulation and flocculation of the metal precipitates and suspended solids. The polymer feed system will consist of a metering pump and a Polyblend mixing system. Emulsion polymer (approximately 30 percent solution) will be fed from a day tank (55-gallon drum) and will be diluted to approximately 1 percent by the Polyblend system before being fed to the rapid mix tank. Sludge from the settler/thickener unit will be pumped to a sludge storage and thickening tank. Effluent from the settler will flow by gravity to the upflow sand filtration unit.

Sand Filtration. The residual suspended solids in the metals precipitation unit effluent will be removed using an upflow, continuous backwash sand filter. A continuous backwash filter was chosen over conventional gravity sand filters or pressure sand filters to eliminate the need for a backwash cycle and the associated storage facilities and pumps. Operator attention requirements are also reduced with a continuous backwashing system. Influent to the filter will flow by gravity from the clarifier. The filter influent will have enough gravity head to pass through the sand bed and into the pH adjustment tank (following the filter) without the need for pumping. Continuous backwash will be provided using an airlift pump, which will pump a small percentage of flow containing the filtered solids from the system. Filter backwash water will flow to the filtrate, decant water and backwash sump prior to being returned to either the phase separator or the main equalization tank.

pH Adjustment. The pH of the effluent from the metals removal system and sand filter will be adjusted down to the acceptable discharge range of 6 to 9 s.u. for final discharge. pH adjustment will be accomplished in a tank which will be equipped with a mixer, pH probe and a controller. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustment. Acid and base will be provided from the bulk storage tanks previously described. The pH adjustment tank will also serve as a wetwell for the effluent pumps which will convey effluent through the GAC contactors or directly to the effluent sump and weir box. The effluent pumps will be sized to pump against the total head associated with GAC system and the elevated effluent sump and weir box.

GAC Polishing Contactors. If the final filtered effluent contains specific chemical constituents in concentrations above the allowable discharge goals, the flow will be routed through GAC contactors for additional treatment. Under normal operating conditions, the use of GAC for effluent polishing is not expected to be necessary. The GAC system will function as a backup system to the other treatment processes should upsets, failures or unexpected problems arise with those systems. The GAC system will also be used during startup to ensure the effluent from the oxidation system meets effluent standards. The GAC contactor system will be a vendor supplied package consisting of two contactor units. The system will have the capability to operate in either parallel or series mode depending on the particular treatment needs. Each column will, however, have the hydraulic capacity to pass the maximum flow from the treatment plant. Replacement of the carbon will need to be conducted periodically when the adsorption capacity has been exhausted. Spent carbon will be replaced by the carbon system supplier (in conjunction with the plant operators). Carbon exhaustion will be determined by effluent sampling and analysis, and by operator experience. Flow to, and through, the GAC system will be controlled by manually adjusting the proper valves.

Effluent Sump and Weir Box. Treated water will flow into the effluent sump and weir box either directly from the pH adjustment tank or from the GAC contactors. The sump will consist of a mixing chamber, baffle wall, stilling chamber, and a V-notch weir. Flow will enter the mixing chamber at which point the pH will be continuously monitored and readjusted if necessary to ensure it is within the desirable range for discharge (6 to 9 s.u.). Acid and base feed systems will be provided for pH adjustments. After pH monitoring and adjustment, the flow will pass through a baffle wall and into the stilling chamber. Flow will pass through the stilling chamber and over a V-notch weir before entering the final discharge pipe. An ultrasonic gauge will continuously measure the water level in the stilling chamber. The ultrasonic gauge will convert the water depth in the stilling chamber to flow rate and provide a local display. The gauge will also be connected to a strip chart recorder for continuous monitoring and recording of discharge flow. A staff gauge will be provided for manually calibrating the ultrasonic flowmeter. A flow paced effluent sampler will collect either composite or discrete grab samples (depending on monitoring requirements) from the stilling chamber via an effluent sample line. Discharge from the effluent sump and weir box will flow by gravity to the wetlands diffuser system for final discharge. A recycle line will be provided from the effluent sump to the filtrate, decant water, backwash sump so that effluent can be recycled to the head of the plant during startup of the treatment system.

Sludge Disposal System. The sludge disposal system provides a means to accumulate and concentrate metals sludge and pretreatment system sludge prior to dewatering for off-site disposal. The elements of this system are: a mixed sludge storage and thickening tanks, polymer feed system, diatomaceous earth feed system, plate and frame filter press and sludge transfer pumps.

Sludge from the metals precipitation system and from the phase separation tanks will be pumped to sludge storage tanks. Initially, one sludge storage tank will be provided for metals sludge. A second sludge storage tank may be provided in the future for storage of sludge from the phase separator prior to initiating dewatering of the OFCA and SBP areas if future testing confirms that a significant amount of sludge will be produced from these areas. Sludge will be allowed to settle and thicken in the storage tanks prior to dewatering. The sludge storage tanks will be equipped with multiple decant ports for the removal of free water. The decant ports will discharge to a pipeline carrying waste liquids to the filtrate, decant, and backwash sump. The decant discharge line will be provided with a sight glass so that the plant operator can assess the quality of the liquid withdrawn.

Thickened sludge from the metals storage tank will be pumped to the filter press for dewatering. Thickened sludge from the phase separator storage tank will be either dewatered or hauled off-site in a liquid form depending on its characteristics. The hazardous characteristics of sludges produced at the treatment facilities will be assessed prior to disposal using the TCLP test. Polymer addition for sludge conditioning will be provided by a metering pump. Liquid emulsion polymer (approximately 30 percent) will be fed directly from 55 gallon drums into the influent to the filter press. An inline mixer will be provided for blending. Filter cake from the press will drop into a roll-off dumpster and will be periodically transported off-site for disposal.

Foul Air Handling System. Those process units that have the potential to generate off-gas or solvent vapors will be covered and vented to an air collection system. The process units which will be connected to the air collection system include:

- Phase separators (1)
- Equalization tanks (2)
- Oil storage tank (1)
- Sludge storage tanks (2)
- Filtrate, decant water, backwash sump (1).

Tanks needing vents will be connected to a vapor phase carbon bed prior to venting to the atmosphere. The volatile organics in the influent groundwater will be destroyed in the main UV oxidation system, and therefore, downstream processes such as such as metals removal, sand filtration, pH adjustment and GAC adsorption will not be vented. These processes will be open to the building atmosphere. The filter press area will be vented to the outside and the roll-off dumpster will be located in a separate enclosed area which will also be vented to the outside.

Moisture Trap. Condensate in the foul air vent lines will be collected in a moisture trap which will be located upstream of the vapor phase carbon canister. Liquid that is collected will flow to the filtrate, decant water, and backwash sump.

Filtrate, Decant Water, Backwash Sump. A main process sump will be provided to collect reject water from all of the unit processes, and from the floor sumps within the building containment structure. The water collected in the sump will be returned to either the influent line to the phase separator or to the main treatment system equalization tank at the discretion of the plant operator.

Area Sumps. Two sumps will be provided in the building containment area to collect spills and washdown water. Any water collected in the sumps will be manually returned to the main process sump using a portable sump pump. A sump will also be located beneath the roll-off dumpster to collect drainage from the dewatered sludge and washdown water from the sludge storage pad. This sump will be equipped with a level controlled sump pump which will return water to the main process sump.

2.4.2. Design Criteria For Major Unit Processes

Table 2-7 provides the design criteria for the key components of each of the main process units or systems.

2.4.3. Major Components

Table 2-8 lists the major components of the main treatment system and their size.

2.4.4. System Operation and Control

The operation of the treatment system will combine automated control of packaged equipment with manual control of flow distribution. The decision to send flow to a specific unit process will be the responsibility of the plant operator. An overall plant monitoring system and control system (Programmable Logic Controller [PLC]) will be provided on the main control panel located in the electrical and instrumentation room. The main control panel will contain status indicators for the process units and tank level alarms. It will also contain control switches for the pumps, mixers, and some of the process equipment. Individual treatment units will be started from local control panels

TABLE 2-7

DESIGN CRITERIA FOR MAIN TREATMENT SYSTEM

Component	Parameter	Design Criteria
Equalization Tank	Number	1
	Capacity	5,000 gal 1.4 hrs HRT @ 60 gpm
Oxidation System	Number	1
	Capacity (max.) Capacity (min.)	70 gpm 10 gpm
	Removal Efficiency @ 60 gpm	90 % for COD, TOC and BOD 99 % specific organic compounds
	Removal Efficiency @ 20 gpm	95 % for COD, TOC and BOD 99.5 % specific organic compounds
Metals Removal	Number	1
	Type	Package rapid mix, flocculation, plate settler
	Rapid Mix Time @ 60 gpm	2 min.
	Flocculation Time @ 60 gpm	20 min.
	Plate Settler Loading Rate @ 60 gpm	600 gpd/sf
Solids Pump	Number	1
	Type	Air Diaphragm
	Max. Flowrate	125 gpm
Sand Filter	Number	1
	Type	Upflow Continuous Backwash
	Loading Rate (max.)	5 gpm/sf
	Media Depth	40 inches
	Media Size	To be determined by supplier.

TABLE 2-7

DESIGN CRITERIA FOR MAIN TREATMENT SYSTEM (CONTINUED)

Component	Parameter	Design Criteria
GAC Contactors	Number	4 (2 initial; 2 *future*)
	Hydraulic Loading Rate	5 gpm/sf (maximum)
	Carbon Type	8 X 30 React
Solids Storage Tank	Number	1
	Capacity	6,500 gal. 3.5 days storage @ [Solids]=3.0 %
Sludge Dewatering		
Press	Number	1
	Type	Plate and Frame Press
	Capacity	2 cycles/day @ 5 days/week
	Volume	30 cf.
Solids Pumps	Number	2
	Type	Air Diaphragm
	Max. Flowrate	125 gpm
Polymer Feed	Number Type	2 Polymer metering pumps
Diatomaceous Earth Feed	Number	1
	Type	Day tank and feed pump
Caustic Storage	Number	1
	Type	Bulk, 50 % sodium hydroxide Soln.
	Volume	2,500 gal.
	Feed Rate (max.)	75 gpd
	Supply (min.)	33 days

TABLE 2-7

DESIGN CRITERIA FOR MAIN TREATMENT SYSTEM (CONTINUED)

Component	Parameter	Design Criteria
Acid Storage	Number	1
	Type	Bulk, 93% sulfuric acid
	Volume	2,500 gal.
	Feed Rate (max.)	48 gpd
	Supply (min.)	50 days
Peroxide Storage	Number	1
	Type	Bulk, 50 % hydrogen peroxide
	Volume	7,000 gal.
	Feed Rate (max.)	88 gpd
	Supply (min.)	80 days
Ferrous Sulfate	Number	1
	Type	5 % solution
	Volume	55 gal. drum
	Feed Rate (max.)	13 gpd
	Supply (min.)	4 days/drum
Effluent Sump and Weir Box	Number	1
	Volume	1,000 gal.
Filtrate, Decant Water and Backwash Sump	Number	1
	Volume	1,000 gal
Vapor Phase Carbon	Number	1
	Air Flowrate (avg.)	6 cfm
	Carbon Type	4x10 React
Air Compressor	Number	2
	Capacity	50 scfm @ 100 psig each
	Receiver Volume	720 gal

TABLE 2-8

MAIN TREATMENT SYSTEM COMPONENTS

Component	Quantity	Description
Influent Pumps	3	30 gpm each Horizontal Centrifugal Stainless Steel
Equalization Tank	1	5,000 gal 8' dia x 13.5' SWD Stainless steel
	1	Tank Mixer 1.5 hp 68 rpm Single propeller
UV Oxidation System	1	30 kW Stainless Steel Reactor with 2" inf. and effl. flanges, Power Supply, and PLC
	1	Acid Delivery System
	1	Peroxide Delivery System
	1	Catalyst Delivery System
Metals Removal	1	Package rapid mix, flocculation, plate settler, sludge thickener
	1	Acid Delivery System
	1	Base Delivery System
	1	Polymer Blending and Delivery System
Solids Pumps	3	Air Diaphragm Pump 1.5" Connections 125 gpm max. flowrate Kynar Body, Viton/Teflon Diaphragm Teflon Ball Valves
Sand Filter	1	Upflow Continuous Backwash 4' dia, 40" sand media
pH Adjustment Tank	1	3,000 gal 8' dia x 9' SWD Epoxy Coated Steel
	1	Tank Mixer 2 hp 250 rpm Single propeller

TABLE 2-8

MAIN TREATMENT SYSTEM COMPONENTS (CONTINUED)

Component	Quantity	Description
GAC Contactors	2 initial 2 *future*	Downflow Pressure Vessels 4' dia x 7.5 H 1,500 lbs carbon, each
Solids Storage Tank	1	6,500 gal. 9' dia x 19' SWD, conical bottom Epoxy Coated Steel
	1	Tank Mixer 1.5 hp 68 rpm Single propeller
Sludge Dewatering	1	Plate and Frame Press 30 cu. ft. unit
	2	Polymer Feed System 3 gph max. with 10:1 turndown ratio
	1	Diatomaceous Earth Feed System
Caustic Storage	1	2,500 gal. 8' dia x 8' SWD HDPE
Acid Storage	1	2,500 gal. 8' dia x 8' SWD HDPE
Peroxide Storage	1	2,500 gal. 8' dia x 8' SWD Stainless Steel or aluminum
Effluent Pumps	3	30 gpm each Horizontal Centrifugal Stainless Steel
Effluent Sump and Weir Box	1	1,000 gal. 4' x 8' x 5' SWD Epoxy Coated Steel 30° V-notch weir
	1	Tank Mixer 0.75 hp 250 rpm Single propeller

TABLE 2-8

MAIN TREATMENT SYSTEM COMPONENTS (CONTINUED)

Component	Quantity	Description
Filtrate, Decant Water and Backwash Sump	1	1,000 gal. 5'4" dia x 6'5" SWD Stainless Steel
	2	Sump pumps 30 gpm each Horiz. centrif. Stainless Steel
Vapor Phase Carbon	1	55 gallon Canister
	1 *future*	4' x 4' x 7' H Bed 1,500 lbs Carbon
Air Compressor	2	Duplex 50 scfm @ 100 psig, each (100 scfm total)
	3	240-gallon reservoir
Process Piping	NA	316 Stainless Steel up to Main UV Oxidation System Schedule 80 PVC from UV Oxidation to Effluent Diffuser System

will operate continuously while the system is on line. The chemical metering pumps for acid and base will operate off of a pH-based control loop. The polymer feed system will operate off the measured flow rate through the UV oxidation system. All metering pumps will have a manually adjustable stroke length to control dosage. The sludge pumps will operate off of a timer or an interface probe.

Sand Filters. Flow through the sand filter will be controlled by manually adjusting the valves on the filter influent line and the filter bypass line. The airlift pump which controls filter backwash will be on continuously when the filter is in operation. Air to the pump will be controlled by a solenoid valve that will allow air supply to the filter when the influent pumps to the UV oxidation system and metals removal system are running.

pH Adjustment. The pH adjustment tank will be supplied with a mixer to blend the pH adjustment chemicals with the filtered effluent. The mixer will operate continuously except when the liquid level in the tank drops to a level of about 3 feet at which point the mixer will shutoff automatically. The equalization tank will serve as a wetwell for the effluent pump station. Pump station control will be based on liquid level in the equalization tank. There will be four level switches in the tank: low level; low operating level; high operating level; and high-high level. Once the liquid level in the tank reaches the high level switch (about 6 feet, deep), one of the three influent pumps will start. If the single pump cannot keep up with the flow entering the tank a second pump will start. If the liquid level in the tank continues to rise above the high level switch and trips the high-high level alarm a signal will be sent to stop the well pumps and extraction pumps in the field and all other liquid treatment systems in the plant. Level indicators and high level alarms will be provided at the main control panel in the electrical and instrumentation control room. Pump and mixer HOA switches will be provided locally and at the MCP.

GAC Polishing Contactors. All operations of the GAC system will be manually controlled by the operators.

Effluent Sump and Weir Box. Flow will enter the mixing chamber at which point the pH will be continuously monitored and adjusted to ensure it is within the desirable range for discharge (6 to 9 s.u.). The mixer will be manually controlled with an on-off switch. Acid and base feed systems will be provided for pH adjustments. The chemical metering pumps for acid and base will operate off of a pH based control loop. An ultrasonic gauge will continuously measure the water level in the stilling chamber. The level will be converted to effluent flow rate which will be continuously recorded. A flow paced effluent sampler will collect composite samples from the stilling chamber via an effluent sample line.

Solids Handling System. All operations of the sludge handling system will be started manually. Valves for decanting supernatant from the sludge storage tanks will be controlled manually. The filter press operation will be initiated manually and the sludge pumps started from an automatic sequence relay controlled by the filter press system. Once initiated, the filter press cycle will be controlled by a vender supplied control system. Polymer and diatomaceous earth addition will be controlled using a metering pump which will be paced based on flow rate to the filter press. Filtrate will return by gravity to the filtrate, decant water and backwash sump, and will be pumped back to either the phase separator or the equalization tank.

Foul Air Handling System. The foul air system will be a passive system, therefore no control mechanisms will be necessary.

Filtrate, Decant Water, Backwash Sump. Pump station control will be based on liquid level in the sump. There will be three level switches in the sump tank: low level; high level; and high-high level. Once the liquid level in the tank reaches the high level switch (about 4 feet, deep), one of the two sump pumps will come on. If the single pump cannot keep up with the flow entering the tank a second pump will start. If the liquid level in the tank continues to rise to the high-high level an alarm will sound. Level indicators and high level alarms will be provided at the main control panel in the electrical and instrumentation control room. Pump HOA switches will be provided locally and at the MCP.

Area Sumps. The two sumps located in the floor of the main building containment area will be pumped out manually by the operators. Pumping of the sump located under the sludge dumpster will be controlled based on level.

2.5 FLOW AND MASS BALANCES ON THE PROCESS TRAIN

Based on the hydraulic design criteria presented earlier, flow and mass balances for the process train were developed. Figure 2-2 and Table 2-9 present the flow and mass balance for the process train at the average influent flows and loading conditions. The various process lines in the figure are labeled with numbers which correspond with the numbers listed in Table 2-9. The flow balance was developed based on 24-hour per day, 7-day per week operation of the system. All other assumptions are listed on the table.

2.5.1. Process Unit Capacities

Phase Separation Unit. From the hydraulic design criteria presented earlier, the flows through a single phase separator will be the following: max-20 gpm (scenario 5); avg-13 gpm (scenario 3); min-8 gpm (scenario 5). The unit selected is rated for a hydraulic loading of 20 gpm.

UV Oxidation Systems. The future UV oxidation system selected for pretreatment of high-strength groundwaters has a maximum hydraulic capacity of 30 gpm. At the influent concentrations previously presented, the system has the capacity to treat 15 gpm. The main UV oxidation system has a rated hydraulic capacity of 70 gpm and can treat flows up to 60 gpm at the pollutant concentrations shown for the PGCS water. The design flows and loadings through the UV oxidation system are the following: max-60 gpm (loading from PGCS); avg-55 gpm (loading from PGCS & pretreatment system effluent); min-20 gpm (loading from PGCS & pretreatment system effluent).

Metals Removal System. The rapid mix and flocculation units were sized for the following hydraulic loading: max-60 gpm; min-20 gpm. The minimum hydraulic retention times for the rapid mix and flocculation units are 2 and 20 minutes at the maximum flow rate, respectively. The Lamella plate clarifier was sized to have a maximum surface overflow rate of 600 gpd/sf at 60 gpm.

Sand Filtration. The sand filtration unit was sized for the same flow rates as the metals removal system. It has a maximum hydraulic loading rate of 5 gpm/sf at a flow rate of 60 gpm.

GAC Contactors. The GAC contactors were each designed for the same flow rates as the metals removal system. In series operation, the units have a hydraulic loading rate of 5 gpm/sf at a flow rate of 60 gpm.

Sludge Handling. The sludge handling facilities were designed to handle the sludge from both the phase separation unit and the metals removal system. The contribution of

TABLE 2-9

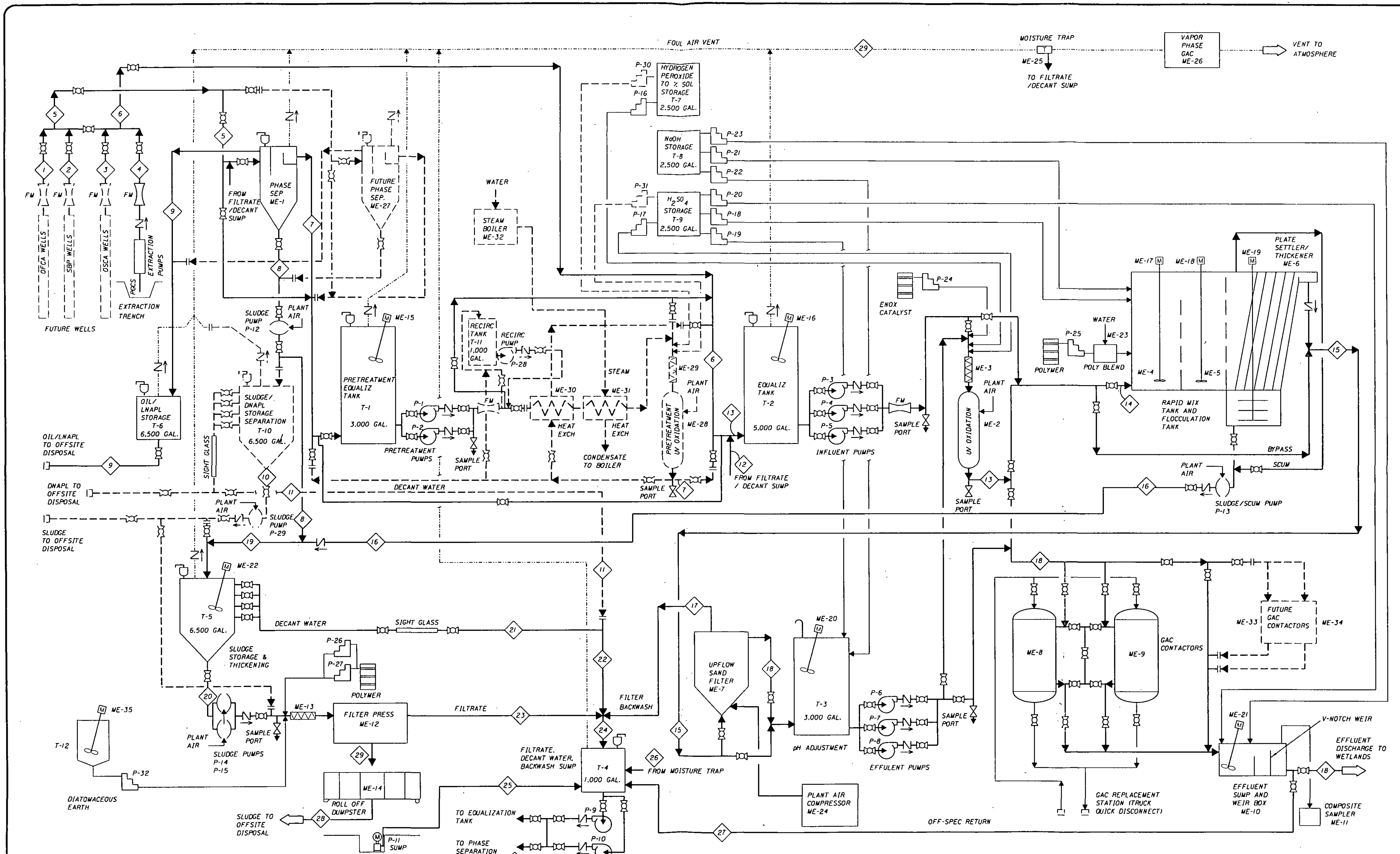
MASS AND FLOW BALANCE

Flow Designation	Description	Flowrate (GPD)	Solids Mass (PPD)
1	Future OFCA Wells	11,500	95
2	Future SBP Wells	7,200	60
3	Future OSCA Wells	43,200	86
4	PGCS Extraction Trench Pumps	17,300	34
5	Combined Source Area Groundwater	18,700	155
6	Combined Low-strength Groundwater	60,500	120
7	Phase Separator Effluent	16,560	35
8	Phase Separator Sludge/DNAPL	1,440	120
9	Phase Separator Oil and Grease/LNAPL	700	0
10	Thickened Phase Separator Sludge	720	120
11	Phase Separator Sludge Decant Water	720	0
12	Filtrate, Decant Water, and Backwash Water	9,100	17
13	Influent to Main UV Oxidation System	86,160	172
14	Influent to Metals Removal Process	86,160	422
15	Effluent from Metals Removal Process	81,200	20
16	Sludge From Metals Removal Process	4,920	402
17	Filter Backwash	2,900	16.5
18	Filter Effluent	78,300	3.5
19	Combined Metals and Phase Separator Sludge	5,240	522
20	Thickened Metals and Phase Separator Sludge	2,090	522
21	Metals and Phase Separator Sludge Decant Water	3,550	0
22	Combined Flow from 11 and 21	4,270	0
23	Filter Press Filtrate	1,880	0.5
24	Combined Filtrate, Decant Water and Backwash Water	9,050	17
25	Sludge Dumpster Washdown Water	40	0
26	Moisture Trap Condensate	10	0
27	Off-Specification Return Water	0	0
28	Dewatered Sludge	210	522
29	Foul Air	40,900	1.75

Notes: All mass units in pounds per day dry solids.

Assumptions:

1. Plant operates 24 hours per day, 7 days per week.
2. Flows are based on 13 gpm contribution from source areas and 42 gpm contribution from PGCS and ONCA.
3. Solids are based on average loadings from each contributing area and are for suspended material only. The increase in solids at the metals precipitation unit (rapid mix influent) is due to conversion of dissolved iron and other metals into solid form.
4. Flow and mass contributions from chemical feed systems are assumed to be minimal and are not included in the balance.
5. Flows to and from the filter press are average daily flows for a 7 day work week, sludge processing facilities will be operated 5 days per week and have been sized accordingly.



MONTGOMERY WATSON
Salt Lake City, Utah

PROCESS FLOW & MASS BALANCE

FIG 2-2

acs_fig 2-2.dgn (09/14/95)

sludge from the phase separator was calculated using an influent groundwater flow rate of 13 gpm from the OFCA and SBP areas. An influent suspended solids concentration of 1,000 mg/l and effluent suspended solids concentration of 240 mg/l were used in the calculation. The contribution of sludge from the metals removal system was calculated based on an influent flow of 60 gpm, influent iron concentration of 200 mg/l and suspended solids concentration of 240 mg/l. The sludge storage systems were sized for seven days of total storage time with 2 days storage in reserve (9 days total storage time) for the phase separator sludge storage system and 3.5 days with 1.5 days in reserve (five days total storage time) for the metals sludge storage system.

2.6 PROCESS CONTROL NARRATIVE

2.6.0.1. The following text describes the overall instrumentation and control strategy for the extraction trench and groundwater treatment system.

Sequence of Operation

2.6.1. General

The process system provided under this contract shall monitor and control the groundwater treatment system as described in the specifications and drawings. The system will consist of local control panels for package units provided by a single manufacturer; local and remote pump controllers, Main Control Panel PLC; level flow and pH sensing equipment, and all other necessary equipment and interconnections or interlocks to synchronize system operation in a continuous and fail-safe condition.

2.6.1.1. Extraction Trench Pumps. Each extraction trench pump shall have a local control panel (LCP) with a motor starter (or variable frequency drive) and local field element instrumentation for monitoring and controlling each pump. Extraction trench monitoring for input to the MCP PLC shall consist of discrete input signals for pump fail based on high-high level in the sump. The influent line header from the extraction trench shall have a flow meter with flow indicator and totalizer located within the Treatment Building. Each extraction trench pump shall have an individual paddle wheel type flow totalizer located at the trench sump. Extraction trench pumps shall shut down if any of the following conditions are activated:

- High level in pretreatment tank
- High level in equalization tank
- High level in phase separator
- System shutdown due to other alarm conditions

2.6.1.2. Phase Separator. The Phase separator shall be a complete package unit from a single manufacture. The unit will provide a system on and high level alarm to the PLC located within MCP. The phase separator shall be remotely controlled from the MCP.

2.6.1.3. Sludge Storage And Thickening Tank. This tank will collect the sludge from the phase separator and plate settler until it can be pumped into the filter press. The tank will have a level sensor to provide an operating range control signal for the tank mixer motor and a high level alarm located on the MCP. The tank mixer motor shall be able to be operated manually or automatically based on level in the tank. On a low level the mixer shall not operate and a shutdown signal shall be sent to the filter press. The tank mixer shall have a local and remote control switch (HOA). A mixer status indicator light shall be located at the MCP.

2.6.1.4. Oil Storage Tank. This tank will collect the oil from the phase separator until it is disposed of off-site. The tank will have a level sensor to provide a tank full indication and high level alarm located at the MCP.

2.6.1.5. Filter Press. The Filter Press shall be a package unit from a single manufacturer. The filter press shall be manually started from a local control panel supplied as part of the package. The local control panel shall control all filter press operations including the main operating sequence, feed pumps, diatomaceous earth mixing and feed system, polymer feed system, and all other ancillary equipment. On a low level signal from the sludge storage and thickening tank the filter press shall shutdown. The filter press shall have a status indicator light at the MCP.

2.6.1.6. Sludge Dewatering Area Sump Pump. The sump pump shall pump water into the process sump and shall be controlled by float switches located in the sump. It shall have a local hand switch.

2.6.1.7. Floor Sump Leak Detection. Each floor sump will have a high level sensor which will provide an input into the PLC located with MCP. Detection of liquid in the sump shall trigger an alarm on the MCP.

2.6.1.8. Pretreatment Tank. This tank will collect the effluent from the phase separator. The tank will have a level sensor to provide a operating range control signal for the tank mixer motor, pretreatment pumps, and high level alarm at the MCP. The tank mixer motor shall be able to be operated manually or automatically based on level in the tank. On a low level the mixer and pretreatment pumps shall not operate. The tank mixer shall have a local and remote control switch (HOA). A mixer status indicator light shall be located at the MCP. A shutdown signal will be sent to the extraction pumps on a high water level in the tank.

2.6.1.9. Pretreatment Tank Pumps. These pumps transfer water to the equalization tank based on the level in the pretreatment tank. The pumps will operate in a lead/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start the leading pump will start. When the level drops enough to stop the pump it will become the lagging pump allowing the next pump to start first when the tank level rises. If the tank level continues to rise the lagging pump will start. The system logic shall start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with both pumps activated. In the event one pump is deactivated (taken off line), the other pump shall perform continuously. On high equalization tank level the pumps will be shutdown. High pretreatment tank level shall trigger an alarm at the MCP.

2.6.1.10. Equalization Tank. This tank will collect the groundwater from the extraction pumps, phase separator, process sump pumps and pretreatment tank. The tank will have a analog level sensor to provide a operating range control signal for the tank mixer motor, influent pumps, and high level alarm. The tank mixer motor shall be able to be operated manually or automatically based on level in the tank. On a low level, the mixer and influent pumps shall not operate. On a high level, a shutdown signal will be sent to the extraction pumps, pretreatment tank pumps, and collection pumps. Also, the high level alarm light will stay on after the tank level drops until an operator pushes the high level reset button. The tank mixer shall have a local and remote control switch (HOA). A mixer status indicator light shall be located at the MCP.

2.6.1.11. Influent Pumps. These variable speed pumps transfer water to the UV Oxidation unit based on the level in the equalization tank and an operator set flow rate into the oxidation unit. The pumps will operate in a lead/lag/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start, the leading pump will start. When the level drops enough to stop the pump, it will become the lagging pump allowing the next pump in sequence to start first when the tank level rises. If the tank level continues to rise and flow is below the set flow rate, the lagging pump will start. If the tank level continues to rise the third pump will start unless the operator-set flow rate will be exceeded. On high pH adjustment tank level or oxidation unit fail, the pumps will be shutdown. On a rising pH adjustment tank level rate greater then the set flow rate the pump's speed will be reduced until the level in the pH adjustment tank stops rising. Each pump shall have a local and remote hand switch (HOA) and individual remote status indicator lights at the MCP. The system logic shall start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with all pumps activated. In the event one or more pumps are deactivated (taken off line), the other pumps shall perform continuously.

2.6.1.12. UV Oxidation Unit. The UV Oxidation unit shall be a complete package unit from a single manufacturer. The package unit shall have its own local control system which will interface with the overall control system for the treatment plant. The package unit's control system will control the flow of Enox catalyst and hydrogen peroxide based on flow rate through the system. UV light intensity shall also be controlled based on flowrate. The local control system will also control acid feed rate based on pH.

The package unit's control system will provide a system on signal to the PLC located in the MCP. The package unit will include a flow meter with indication and flow totalization. It will send a flow control signal to the PLC located in the MCP for use in controlling the chemical feed pumps, influent pumps, and effluent pumps. The system will also provide a means for the operator to enter a flowrate set point that will be sent to the PLC located in the MCP.

2.6.1.13. Chemical Feed Pumps for pH Adjustment Tank (T-3) and Effluent Weir Box (ME-10). These pumps transfer chemicals into the process water at a variable rate based on pH. The pumps shall have their rates adjusted by the pH rate signal from the pH meter located in each respective tank. Each pump shall have a local and remote hand switch (HOA) and individual status indicator lights at the MCP.

2.6.1.14. Rapid Mix Tank, Flocculation Tank, and Plate Settler. The rapid mix tank, flocculation tank, and plate settler shall be a complete package unit from a single manufacturer. The package unit shall have its own local control system which will interface with the overall control system for the treatment plant. The package unit's control system will control the flow of polymer based on flowrate through the UV oxidation system. The rapid mix tank shall have a pH sensor which will provide the control signal for acid and base additions. The package unit's control system will control the flow of acid and base according to pH in the rapid mix tank. The pH sensor will provide a signal to the PLC located in the MCP. Low pH and high pH alarms shall be located at the MCP. The rapid mix, flocculation and plate settling unit shall have a remote hand switch (HOA) and individual status indicator lights at the MCP.

2.6.1.15. Sand Filter. The Sand Filter shall be a complete package unit from a single manufacture. It shall be supplied as part of the Rapid Mix Tank, Flocculation Tank, and Plate Settler Package. Control of the sand filter shall be provided by the local control system that is part of the Rapid Mix Tank, Flocculation Tank, and Plate Settler system. When there is no effluent flow from the oxidation unit the control system shall shutdown the air supply to the filter.

2.6.1.16. pH Adjustment Tank. This tank will collect the effluent from the sand filter. The tank will have an analog level sensor to provide an operating range control signal for the tank mixer motor, influent pumps, effluent pumps, and high level alarm located on the MCP. The tank mixer motor shall be able to be operated manually or automatically based on level in the tank. On a low level the mixer and effluent pumps shall not operate. A shutdown signal will be sent to the influent pumps on a high level. On a rising tank level rate greater then the set oxidation unit flow rate, a slowdown signal will be sent to the influent pumps to reduced their speed until the level in the tank stops rising. The tank mixer shall have a local and remote control switch (HOA). A mixer status indicator light shall be located at the MCP. The tank shall have a pH sensor that will provide a signal to the PLC located in the MCP. The pH signal shall be used to control the acid and base flow rates into the tank. High pH and low pH alarms shall be located at the MCP.

2.6.1.17. pH Adjustment Tank Pumps. These variable speed pumps transfer effluent water to the GAC contactors based on the level in the pH adjustment tank and an operator set flow rate into the oxidation unit. The pumps will operate in a lead/lag/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start the leading pump will start. When the level drops enough to stop the pump it will become the lagging pump allowing the next pump in sequence to start first when the tank level rises. If the tank level continues to rise and flow is below the set flow rate, the lagging pump will start. If the tank level continues to rise the third pump will start unless the flow rate will be exceeded. Each pump shall have a local and remote hand switch (HOA) and individual status lights at the MCP. The system logic shall start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with all pumps activated. In the event one or more pumps are deactivated (taken off-line), the other pumps shall perform continuously.

2.6.1.18. Process Sump (Filtrate, Decant Water, Backwash Sump). This tank will collect miscellaneous waste process water from several sources. The tank will have a level sensor to provide a control signal for the tank transfer pumps and high level alarm at the MCP. On a low level, the transfer pumps shall not operate.

2.6.1.19. Process Sump Pumps. These pumps transfer water to the equalization tank or the phase separator based on the level in the process sump. The pumps will operate in a lead/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start the leading pump will start. When the level drops enough to stop the pump it will become the lagging pump allowing the next pump to start first when the tank level rises. If the tank level continues to rise the lagging pump will start. On high equalization tank or separator level the pumps will be shutdown. Each pump shall have a local and remote hand switch (HOA) and individual status lights at the MCP. The system logic shall start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with both pumps activated. In the event one pump is deactivated (taken off-line), the other pump shall perform continuously.

2.6.1.20. Weir Box. This tank allows for final pH monitoring and adjustment, and effluent flow rate measurement and totalization. This tank contains a mixer motor that will be manually controlled with a local hand switch. A pH sensor shall be placed such that it sends the pH level of the final effluent stream to the PLC located in the MCP. Chemical feed pumps shall be controlled by the signal from the pH meter. Low pH and high pH alarm indicator lights shall be located at the MCP. A flow meter with flow indication and totalization will be mounted locally in the weir box. The flow meter shall transmit an analog signal to the PLC located in the MCP. The flow signal shall be used to control the composite sampler.

2.6.1.21. Composite Sampler. The composite sampler shall be a complete package unit from a single manufacture. It will sample the effluent based on the flow signal from the flow meter located in the weir box.

2.6.1.22. Chemical Storage Tanks: All chemical tanks will have local level indication and low level sensors to provide a input into the PLC located in the MCP. Each tank shall have a low-level alarm located at the MCP.

2.7 ARCHITECTURAL/STRUCTURAL DESIGN ASPECTS

2.7.0.1. A treatment building will be constructed at the site to house all the treatment equipment, the control room, an office, a restroom and shower, a laboratory, a maintenance room, and a mechanical room for a water heater, air compressor, and future boiler. The treatment building will be a 6,000 square foot pre-manufactured metal building. The building will consist of standard bays with an overall dimension of 60 feet by 100 feet. The inside roof clearance at the exterior walls will be approximately 26 feet. No interior columns will be needed. Foundations for the building will consist of shallow reinforced concrete spread footings at building columns. The building floor will be a concrete slab on grade with housekeeping pads/foundations for equipment. A 6-inch curb will be placed around the edge of the building to provide secondary containment for the general processing facilities. Separate secondary containment areas will be provided for the chemical storage tanks.

2.7.0.2. Interior walls in the building will be finished with painted gypsum board applied to furring channels or steel studs. Floor in the processing and chemical storage areas will be sealed with a chemical resistant epoxy based concrete sealing system suitable for use in chemical containment structures. Floors in other areas will be concrete finished with urethane except in the restroom which will have sheet vinyl. Ceilings will be acoustic lay-in ceilings. The entire building will be provided with adequate insulation. The office, laboratory, electrical room, bathroom will be provided with a HVAC system to maintain the temperature between 65 and 80° F. The general process area, storage room and mechanical room will not be air conditioned but will be heated and ventilated to maintain the temperature in the 60° F to 95° F range.

2.7.0.3. The filter press area will be enclosed separately using gypsum board in order to control potential odors associated with the sludge processing and storage. An exhaust fan will be included to ventilate this area. A separate rollup door will also be provided on one of the exterior walls to allow for removal of the roll-off dumpster.

2.7.0.4. An oversized rollup door will be provided on the northern wall of the building to allow additional treatment equipment to be brought in if needed in the future. Ramps will be provided at all entrances into the building to allow easy access.

2.7.0.5. Fire extinguishers will be provided throughout the building and an emergency eyewash and shower will be provided just outside the laboratory. A fire sprinkler system will be installed if required by local codes.

2.8 CIVIL DESIGN ASPECTS

2.8.1. Groundwater Extraction Trench

2.8.1.1. The groundwater extraction trench ("extraction trench") will be 1,200 feet long and between 12 and 16 feet below ground surface. The trench will be constructed utilizing the "one pass" trenching method to minimize the impacts to the wetlands and to avoid problems associated with excavating in areas with a high water table. The trench will be backfilled with sand or gravel to provide a flow path to the extraction drain pipe. The drain pipe will be 6-inch diameter perforated chemical resistant high density polyethylene piping and it be covered with a filter fabric sock. The pipe will slope at a rate of 0.005 feet per foot to one of two sumps located as shown on the accompanying drawings. The drain pipe elevation will vary from approximately 2 feet above the clay layer at the sumps to about 5 feet above the clay layer at the pipeline high points. Groundwater will be extracted from the sumps using electrical submersible pumps and it will be conveyed to the treatment building using a buried 2-inch HDPE pipe.

2.8.2. Effluent Discharge

2.8.2.1. Treated groundwater will flow by gravity from the effluent weir box in the treatment building to a valve vault where flow will be split into three discharge pipes. Each discharge pipe will then distribute a portion of the effluent to a different location in the wetlands. At the end of each discharge pipe, a 4-inch diameter by 10-foot long PVC diffuser will be used to spread the water such that it does not adversely impact the wetlands. The diffuser system will be set in a man-made embankment to protect the pipes from freezing. The embankment will be about 5 to 6 feet high at its peak and riprap will be placed below the diffuser to reduce erosion. Side slopes greater than 2H:1V will be supported by shotcrete cover. All effluent conveyance piping will be 4-inch diameter PVC and it will have a minimum soil cover of 4 feet for freeze protection.

2.8.3. Access Road

2.8.3.1. An access road to the treatment building will be brought in from near the existing ACS entrance which is located on Colfax Street at the northeast corner of the facility.

2.8.3.2. The access road will be 24 feet wide with slopes to existing grade at 3H:1V. The road will be constructed of 12 inches of gravel base. The access road will approach the treatment building along the existing fenceline on the northside. Vehicle access will be provided to all sides of the treatment building and sufficient space will be included to allow a tractor-trailer to turn around.

2.8.3.3. Surface water drainage from the northern sections of the ACS production facility will be channeled to a culvert under the access road. Drainage from the western sections of the ACS production facility will be channeled to the natural drainage ditch south of the treatment building turnaround.

2.8.4. Utilities

2.8.4.1. Water will be supplied to the treatment building through a new 8-inch line that will be connected to an 8-inch water line that was recently installed in Colfax Avenue by the City. A tee will be installed in the line which runs from the main located in the street to the ACS production facility. Gas service will be supplied to the treatment building through a 2-inch plastic pipe acceptable to the local gas company. Connection will be to an existing 4-inch iron line on the ACS production facility. Sanitary sewer service will be provided by installing a 6-inch PVC pipe from the treatment building to an existing sewer located to the south of the building near the railroad tracks.

2.8.5. Structures Subsurface

2.8.5.1. The treatment building, peroxide storage tank pad and containment structure and valve vault will be constructed on top of 12 inches of drainage gravel.

2.9 ELECTRICAL DESIGN ASPECTS

2.9.0.1. A separate electrical service will be provided to power the treatment building and extraction pumps in the trench. The service will consists of a pole or pad mounted transformer located next to the treatment building. A 480 volt power circuit will be run from the transformer to the main switchboard and motor control center in the building. No emergency or auxiliary services will be provided, except for battery backup of the PLCs and specific units with memory banks. Distribution of power from the control room will be accomplished using cable trays or rigid steel conduit. Building and outdoor lighting will follow normal standards using fluorescent fixtures within the building and flood lamps outside.

Section 3

3.0 PERMIT/APPROVAL REQUIREMENTS

As previously discussed, the remedial activities are being conducted pursuant to a Unilateral Administrative Order (UAO) which defines the framework under which the remedial design and remedial action is to proceed. The UAO states in paragraph 28 that the actions required by the UAO are consistent with the National Contingency Plan, as ammended, and CERCLA. Paragraph 52 goes further to state that permits are not required for any on-site activities. Given these facts, no permits are needed for construction or operation of the PGCS where these activities are conducted on site. Thus, design concepts and details have considered, as appropriate, compliance with the intent of applicable laws or regulations, even though permits will not be required. Key regulatory programs which have been evaluated are discussed in the following paragraphs.

3.1 EFFLUENT DISCHARGE QUALITY CRITERIA

Treated groundwater from the PGCS treatment facility will be discharged to the adjacent wetlands which are located on site. As stated in the NCP and the UAO, a permit for discharging the effluent is not required since the discharge point will be on site; however, IDEM has issued a NPDES permit. The substantive requirements of the permit will need to be met. Table 2-4 in Section 2.0 provides the effluent limits for discharge of treated groundwater to the adjacent wetlands.

3.2 WETLANDS DISCHARGE REQUIREMENTS

An evaluation of potential impacts that the discharge of treated effluent might cause to the wetlands was performed by reviewing the historical water levels, the existing plant species, and the aerial extent of the wetlands; conducting hydrogeologic modeling; and identifying the invert elevations of outlets from the wetlands. The following are the major findings:

- The wetlands is fairly large (about 25 acres) and the maximum amount of water to be discharged is relatively small (60 gpm).

- The groundwater to be removed and treated would discharge to the wetlands anyway if the proposed extraction trench is not constructed. Therefore, the discharge of this treated effluent to the wetland will not significantly change the overall water balance in the wetlands.

- The hydrogeologic modeling indicates that ponding/flooding of the wetlands will not occur.

- The wetlands has an outlet via a ditch and culvert under the railroad tracks to the south. The outlet will control the water level in the wetlands.

Based on the evaluation, the discharge of treated groundwater will have no adverse impacts on the wetlands. Construction activities in or near wetland areas are normally governed by the Corps of Engineers. Since the ACS site is a Superfund site, the Corps of Engineers has stated that they will relegate the decision-making authority to the lead agency—U.S. EPA—and therefore no specific permits or approvals are needed from the Corps. The Corps of Engineers requested that a letter be sent to them describing the proposed activity and the circumstances. They will then respond with written confirmation that a permit is not needed. (A letter has been sent to the Corps for this purpose, and we are awaiting a reply letter.)

3.3 WELL INSTALLATION REQUIREMENTS

Pursuant to CERCLA and UAO authorization, no permits are required for well installation at the ACS Site. Design and construction details regarding well installation will be prepared in advance of construction activities and submitted to the U.S. EPA for approval.

3.4 CONSTRUCTION/BUILDING PERMIT

Pursuant to CERCLA and UAO authorization, no permits are required for installation of a treatment building at the ACS Site. However, the building design, including the foundation and structural design, will meet the applicable state and local guidelines and building codes. In addition to meeting the building codes, the building will also meet the requirements of the Indiana Fire Prevention Code.

3.5 AIR DISCHARGE REQUIREMENTS

Within the CERCLA authorization, no permits are required for discharge to the atmosphere. However, the PGCS treatment facility would have to meet the intent of federal, state, and local guidelines regarding air emissions. The ACS Steering Committee will provide a letter to the U.S. EPA with information regarding the treatment facility design and operations, an estimate of air emissions, and the measures and means to comply with the air emissions guidelines.

3.6 UTILITY CONNECTIONS

The utility connections required for the PGCS construction and operation include water (both fire water and potable water), sanitary sewer, natural gas, and electric power supply. The permit/approval requirement for each connection is described below.

3.6.1. Water

Potable and fire water for the PGCS treatment facility will be brought to the treatment system building by installing a new line from the water main recently installed in Colfax Avenue. A separate meter will also need to be installed.

3.6.2. Sanitary Sewer Connection

Waste from the restroom and the laboratory located inside the treatment facility building will be discharged to the City of Griffith sanitary sewer. A new connection will need to be provided for the sanitary waste from the PGCS treatment facility. The City of Griffith stated that it will require a new sewer connection permit before the tie-in can be made. The tie-in will have to meet the City of Griffith requirements and codes, and will have to be approved by a City inspector before discharge can be made to the sewer. The City will assess their sewer connection fee as part of the application.

3.6.3. Natural Gas and Power Supply

Natural gas and electricity are currently available at the ACS Site. These utilities are provided by the Northern Indiana Public Service Company (NIPSCO). Telephone conversations with Mr. Larry McDonald of NIPSCO suggest that a new gas and power service would be preferable for the PGCS treatment facility. No permits will be required for these services. Instead, prior to the start of the construction activities, a letter requesting additional services, and stating the anticipated gas usage and electrical load will be issued to NIPSCO. This letter would suffice as notice for NIPSCO to proceed. After receiving the anticipated loads, NIPSCO will determine the connection fees for the new services.

3.7 TEMPORARY DISCHARGE OF CONSTRUCTION DEWATERING WATER

Temporary dewatering will occur at the ACS Site during construction of the groundwater treatment facility, building foundation, sewer line, conveyance line, and possibly the pipe trench. Dewatering water generated during the construction activities will be collected and the solids will be allowed to settle out. The settled water will then be treated by filtration and granular activated carbon adsorption. The temporary treatment system will be located close to the construction area to prevent long pipe runs. Treated water from the carbon units will be discharged to nearby drainage pathways. Spent cartridge filters and settled solids will be collected and periodically transported off site for disposal. Montgomery Watson will seek approval from the U.S. EPA and IDEM prior to start of the construction activities.

Section 4

4.0 CONSTRUCTION COST ESTIMATES AND SCHEDULE FOR PROJECT COMPLETION

4.1 CONSTRUCTION COST ESTIMATES

The total estimated construction costs for the perimeter groundwater extraction and treatment system are provided in Table 4-1. The costs presented in the table are the installed costs for the facilities including equipment purchase costs, installation, and construction management costs. Table 4-1 also provides an estimate of the annual operations and maintenance costs based on 24-hour per day, 365-day per year operation of the pumping and treatment system at a flow rate of 50 gpm. [The treatment system has the capacity to operate at 60 gpm, but 50 gpm was used to provide a more realistic estimate of the operating costs.] The operations and maintenance cost presented in the table assume that the actual methylene chloride concentration in the effluent from the UV oxidation system will be below the effluent limit established by IDEM. If this is not the case, the carbon consumption cost could increase substantially or an air stripper may have to be added to the process train, thus increasing the capital costs.

4.2 SCHEDULE FOR PROJECT COMPLETION

The schedule for completion of the pre-construction and construction activities is being integrated into the overall project schedule. A detailed, specific schedule for the construction will be developed once an approximate start date is agreed upon. Construction of the PGCS facilities is anticipated to take approximately nine months from notice-to-proceed through initiation of startup and system testing. Startup and testing of the facilities should take an additional two months following completion of construction.

TABLE 4-1

ESTIMATED COSTS
PERIMETER GROUNDWATER CONTAINMENT AND TREATMENT SYSTEM DESIGN/BUILD CONSTRUCTION

Item Number	Capital Costs Description		Cost
1	Permits/ Notifications		$2,300
2	Construction Surveying		$9,000
3	Temporary Services		$40,000
4	Site Preparation		$79,000
5	General Earthwork		$265,000
6	Underground Utilities		$65,000
7	Perimeter Groundwater Extraction Trench		$270,000
8	Groundwater Treatment Building		$350,000
9	Laboratory Furnishings and Equipment		$46,000
10	Treatment Equipment and Installation		$1,121,000
		Subtotal	$2,247,300
11	Contractor's Labor and Expenses		$326,000
		Subtotal	$2,573,300
12	Contractor's Insurance, Overhead, and Profit		$322,000
		Subtotal	$2,895,300
13	Engineering Oversight and Technical Support		$186,000
	Total Project Capital Cost		**$3,081,300**

Item Number	O & M Costs Description	Annual Cost
1	Power	$59,000
2	Lamp Replacement	$10,000
3	Chemicals	$81,000
4	Carbon	$15,000
5	Sludge Disposal (as nonhazardous waste)	$26,000
6	Labor (2 shifts per weekday plus 1 shift each weekend day)	$249,600
7	Equipment Maintenance	$12,500
8	Compliance Monitoring	$25,000
9	Process Monitoring	$25,000
	Total Annual O&M Costs	**$503,100**

Section 5

5.0 AMENDMENT 1
TO
SITE SAFETY PLAN
PRE-DESIGN SITE INVESTIGATION
AMERICAN CHEMICAL SERVICE, INC.
GRIFFITH, INDIANA
August 1995

5.1 INTRODUCTION

This Site Safety Plan (SSP) amendment has been prepared to supplement the Pre-Design Site Investigation, American Chemical Service, Inc. (ACS) SSP (referred to hereafter as the original SSP) developed in August 1995 for field activities at the ACS site in Griffith, Indiana. This amendment is designed to provide site-specific information for the protection of field team members during the Perimeter Groundwater Containment System (PGCS) construction. Field team members will follow the original SSP, except where noted in this amendment.

5.2 BACKGROUND

The PGCS construction project includes the following:

- A 12 to 16 foot deep extraction trench to cut off groundwater flow in the upper aquifer along the downgradient perimeter of the site.

- A treatment system and an associated building and access road.

- A treated effluent conveyance line and wetlands discharge structures.

The scope of work for this project is discussed in detail in Sections 1 through 4 of this document.

5.3 CONSTRUCTION ACTIVITY HAZARD ANALYSIS

Montgomery Watson will have at least one person at ACS during the construction to provide project management services and oversee site activities. Montgomery Watson will also provide personnel to conduct site health and safety meetings and conduct health and safety audits. Specialty subcontractors will perform site tasks, which include:

- Monitoring well and piezometer installation
- Soil excavation and trenching
- Backfilling and soil compaction
- Electrical line installation
- Conveyance pipeline installation
  - from the groundwater extraction trench to the treatment system
  - from the treatment system to the wetlands discharge structure
- Welding
- Construction of central control building, treatment unit, and access road

Standard operating procedures (SOPs) for safe operation of equipment and execution of work will be brought on-site by the subcontractors. Included herein are some general practices that will be enforced on-site during the PGCS construction activities.

The following hazards are associated with many site activities:

- Chemical hazards
- Noise
- Biological hazards
- Temperature stress
- Working near highways or construction site traffic
- Working at hazardous waste sites
- Ladders
- Fall hazards
- Lifting and materials handling
- Working with and around heavy equipment.

Chemical hazards from site contamination are addressed in Section 2 of the original SSP. Noise and biological hazards are addressed in Section 4 of the original SSP. The SOP for temperature stress is found in Appendix E of the original SSP, and the remaining hazards listed above are addressed in Appendix F of the original SSP.

General hazards specific to each construction activity are listed in Table 5-1, and discussed in the sections below.

5.3.1. Monitoring Well and Piezometer Installation

Hazards associated with monitoring well and piezometer installation are addressed in the original SSP.

5.3.2. Soil Excavation and Trenching

All trenching operations will be conducted in accordance with 29 CFR 1926 Subpart P. Safety precautions to be used during excavation and trenching activities are summarized below.

The following procedures will be used when operating trenching equipment or a backhoe during excavation or trenching activities:

- Safety rules for heavy equipment and traffic discussed in Section 4 of the original SSP will be followed.
- All utilities will be cleared as discussed in Section 4 of the original SSP.
- Air monitoring will be performed as described in Table 5-1. A portable sprayer will be used to suppress any dust generated during invasive work. Dust suppression will eliminate the need to conduct real time air sampling for contaminants that adhere to dust, such as metals.
- The buddy system will be employed at all times.
- No trench will be left unattended or open without adequate barricades, caution tape, and safety signs.
- Personnel and equipment will maintain a minimum 2 foot clearance from the edge of the excavation.

TABLE 5-1

CONSTRUCTION ACTIVITY HAZARD ANALYSIS

Task	General Hazards	Initial Level of PPE	Air Monitoring[a]

Soil Excavation and trenching	Exposure to site contaminants
	Noise
	Biological hazards
	Temperature stress
	Construction site traffic
	Slip/trip/fall
	Operation of heavy equipment
	  Trenching equipment
	  Backhoe
	Electrocution
		Level D	Continuously for organic vapors, vinyl chloride, oxygen, explosive vapors.

Backfilling and soil compaction	Exposure to site contaminants
	Noise
	Biological hazards
	Temperature stress
	Construction site traffic
	Slip/trip/fall
	Operation of heavy equipment
	  Trenching equipment
	  Backhoe
		Level D	Continuously for organic vapors, vinyl chloride.

Electrical line installation	Exposure to site contaminants Noise Biological hazards Temperature stress Construction site traffic Slip/trip/fall Heavy lifting Electrocution	Level D	Before entering trench for organic vapors, vinyl chloride, oxygen, explosive vapors.
Conveyance pipeline installation	Exposure to site contaminants Noise Biological hazards Temperature stress Construction site traffic Slip/trip/fall Heavy lifting Exposure to doping/bonding compounds	Level D	Before entering trench for organic vapors, vinyl chloride, oxygen, explosive vapors The subcontractor's industrial hygienist to determine if air monitoring is required for doping/bonding compounds.
Welding	Exposure to welding materials Noise Biological hazards Temperature stress Construction site traffic Slip/trip/fall Fire and explosion	Level D	The subcontractor's industrial hygienist to determine if air monitoring is required.

Construction of central control building, treatment unit, and access road	Exposure to site contaminants
	Noise
	Biological hazards
	Temperature stress
	Construction site traffic
	Use of ladders
	Slip/trip/fall
	Heavy lifting
	Operation of heavy equipment
	  Bulldozer
	  Crane
	  Backhoe
	Operation of industrial trucks
	  Forklift
	Portable hand and power tool use
		Level D	Continuously during intrusive activities for organic vapors, vinyl chloride, oxygen, explosive vapors. During non-intrusive activities, no air monitoring is required.

(a) Organic vapors—Photoionization detector with 11.7 eV lamp
Vinyl chloride—Colorimetric indicator tube, vinyl chloride 0.5/a order number 67 28061
Oxygen—Industrial Scientific direct reading oxygen meter
Explosive vapors—Industrial Scientific combustible gas meter

- Suitable storage for all tools, materials, and supplies will be provided by the contractor (or subcontractor).

- Work areas will be kept free of materials, obstructions, and substances that could cause a surface to become slick or otherwise hazardous.

- Tools and equipment will be used in accordance with the manufacturers recommended methods. The operators shall be responsible for establishing safe equipment use procedures and communicating these to site workers.

- Unattended excavations must be properly covered or otherwise secured when work is not active.

- Soil shall be backfilled as soon as possible.

Employees will not enter any trenches greater than 4 feet in depth during this project. Should this change, another amendment will be written.

5.3.3. Backfilling and Soil Compaction

Safety precautions for backfilling and soil compaction are covered in Section 1.3.2. of this amendment.

5.3.4. Electrical Line Installation

Electrical hazards are summarized in Section 4 of the original SSP. Controlling electrical hazards and ground-fault protection on construction sites are discussed in more detail in Attachment A of this amendment. Electrical work will only be conducted by a trained, experienced, and licensed electrical subcontractor, and will conform with 29 CFR 1910.147.

5.3.5. Conveyance Pipeline Installation

The specific hazards associated with conveyance pipeline installation include possible excavation entry and connecting polyvinyl chloride (PVC) or polyethylene piping. Employees will not enter any trenches greater than 4 feet in depth during this project. PVC connections are accomplished using doping and bonding compounds. The subcontractor installing the pipelines will provide workers with material safety data sheets (MSDS) explaining the potential hazards associated with the materials used, and will develop safe handling procedures including the use of appropriate PPE.

5.3.6. Welding

The specific hazards associated with welding include fire and explosion, exposure to toxic gases and fumes, and exposure to dangerously intense light. Should welding be necessary, all appropriate hot work permits will be obtained in advance and all unnecessary personnel shall be cleared from the welding site. Welders shall wear appropriate PPE and conduct appropriate air monitoring. The SSO will be responsible for fire control measures as outlined in Appendix F of the original SSP. Hazards associated with welding are discussed in more detail in Attachment A of this amendment.

5.3.7. Construction of the Central Control Building, Treatment Unit, and Access Road

Specific hazards associated with construction of the central control building, treatment unit, and access road include industrial truck and crane operation, and the use of portable hand and power tools. Safety precautions for these activities are found in Section 4 of the original SSP and Attachment A of this amendment.

5.4 TASK-SPECIFIC LEVELS OF PROTECTION

The initial level of protection and air monitoring required for each site activity is listed in Table 5-1. The air monitoring equipment and action levels for upgrading personal protective equipment (PPE) are discussed in Section 5.0 of the original SSP.

ATTACHMENT A

GENERAL HEALTH AND SAFETY PROCEDURES

OPERATING RULES FOR INDUSTRIAL TRUCKS

The following are established as Operating Rules - Industrial Trucks. The term "Industrial Trucks" includes mobile power driven trucks or tractors used for hauling, pushing, lifting or tiering materials. Compliance with these Rules is required of all employees. Violation of these Rules will result in disciplinary action.

1. Only drivers authorized by the employer and trained in the safe operations of industrial trucks or industrial tow tractors shall be permitted to operate such vehicles. Methods shall be devised to train operators in safe operation of powered industrial trucks.

   Drivers shall not operate trucks other than those for which they are authorized. Trainees may be authorized to operate trucks provided they are under competent supervision.

2. Drivers shall check the vehicle at least once per shift, and if it is found to be unsafe, the matter shall be reported immediately to a foreman or mechanic, and the vehicle shall not be put in service again until it has been made safe. Attention shall be given to the proper functioning of tires, horn lights, battery, controller, brakes, steering mechanism, and the lift system of fork lifts (fork, chains, cable, and limit switches)

3. Vehicle shall not exceed the authorized or safe speed, always maintaining a safe distance from other vehicles, keeping the truck under positive control at all times and all established traffic regulations shall be observed. For trucks traveling in the same direction, a safe distance may be considered to be approximately 3 truck lengths or preferably a time lapse- 3 seconds- passing the same point.

4. No riders shall be permitted on vehicles unless provided with adequate riding facilities.

5. Stunt driving and horseplay are prohibited.

6. Loaded vehicles shall not be moved until the load is safe and secure.

7. When leaving a vehicle unattended, the power shall be shut off, brakes set, the mast brought to the "vertical position" , and forks left in the down position. When left on an incline, the wheels shall be blocked.

   - NOTE: A powered industrial truck is unattended when the operator is 25 feet or more away from the vehicle which remains in his view, or whenever the operator leaves the vehicle and it is not in his view.

   - When the operator of an industrial truck is dismounted and within 25 feet of the truck still in his view, the load engaging means shall be fully lowered, controls neutralized, and the brakes set to prevent movement.

8. Trucks shall not be driven up to anyone standing in front of a bench or other fixed object of such size that the person could be caught between the truck and object.

9. Operators shall look in the direction of travel and shall not move a vehicle until certain that all person are in the clear.

10. Vehicles shall not be run onto any elevator unless specifically authorized to do so. Before entering an elevator, driver shall make sure that the capacity of the elevator is not exceeded. Once on an elevator, they shall shut off the power and set the brakes.

11. Vehicles shall not be operated on floors, sidewalk doors, or platforms that will not safely support the loaded vehicle.

   - Any damage to industrial trucks and/ or structures shall be reported immediately to the foreman.

The following additional rules shall apply to fork lift trucks:

12. Employees shall not ride on the forks of lift trucks.

13. The forks shall always be carried as low as possible, consistent with safe operation.

14. Extreme care shall be used when tilting loads.

15. Vehicles shall not be driven in and out of highway trucks and trailers at unloading docks until such trucks are securely blocked and brakes set.

16. Employees shall not place any part of their body outside the running lines of the industrial truck or between mast uprights or other parts of the truck where shear or crushing hazards exist.

17. Employees shall not be allowed to stand, pass, or work under the elevated portion of any industrial truck, loaded or empty, unless it is effectively blocked to prevent it from falling.

18. Railroad tracks shall be crossed diagonally wherever possible. Parking closer than 8 1/2 feet from centerline of railroad track is prohibited.

19. The width of one tire on the powered industrial truck shall be the minimum distance maintained from the edge by the truck while it is on any elevated dock, platform or freight car.

20. When powered industrial trucks are used to open and close freight car doors, the following provisions shall be complied with:

    - (A) A device specifically designed for opening or closing freight car doors shall be attached to the truck.
    - (B) The force applied by the device to the freight car door shall be applied parallel to the direction of travel of the freight car door.
    - (C) The entire door opening operation shall be in full view of the operator.
    - (D) The truck operator and other dock employees shall be clear of the area where the door might fall while being opened.

21. Prior to driving onto trucks, trailers and railroad cars, their flooring shall be checked for breaks and other structural weaknesses.

22. Other trucks traveling in the same direction shall not be passed at intersections, blind spots, or dangerous locations.

23. The driver shall slow down and sound the horn at cross aisles and other locations where vision is obstructed. If the load being carried obstructs forward view, the driver shall be required to travel with the load trailing.

24. Grades shall be ascended or descended slowly.

    - (A) When ascending or descending grades in excess of 10 percent, loaded trucks shall be driven with load upgrade.

    - (B) On all grades the load and load engaging means shall be tilted back if applicable and raised only as far as necessary to clear the road surface.

    - (C) Motorized hand and hand/rider trucks shall be operated on all grades with the load-engaging means downgrade.

25. Trucks shall not be loaded in excess of their rated capacity.

26. Motorized hand trucks shall enter elevators or other confined areas with the load and forward.

27. No truck shall operate with a leak in the fuel system.

28. Extreme care shall be taken when tilting loads. Tilting forward with the load engaging means elevated shall be prohibited except when picking up a load. Elevated loads shall not be tilted forward except when the load is being deposited onto a storage rack or equivalent. When stacking or tiering, backward tilt shall be limited to that necessary to stabilize the load.

29. The load engaging device shall be placed in such a manner that the load will be securely held or supported.

30. Special precautions shall be taken in the securing and handling of loads by trucks equipped with attachments, and during the operation of these trucks after the loads have been removed.

SOURCE: CCR General Industry Safety Order Section 3669

OPERATING RULES FOR CRANES

The following is based on a set of operating rules for crane operators, from the Crane Manufacturers Association of America, Inc.

1. Crane controls should be operated smoothly and gradually to avoid abrupt, jerky movements of the load. Slack must be taken from the sling and hoisting ropes before the load is lifted.

2. The crane should be centered over the load before starting the hoist to avoid swinging the load as the lift is started. Loads should not be swung by the crane's reach areas not under the crane.

3. Crane hoisting ropes should be kept vertical. Cranes must not be used for side pulls.

4. The block should never be lowered below the point where less than two full wraps of rope remain on the hoisting drum. Should all the rope be unwound from the drum, it should be rewound in the correct direction and seated properly in the drum groove, otherwise the rope will be damaged and the hoist limit switch will not operate to stop the hoist in the high position.

5. Everyone in the immediate area should be clear of the load and aware that a load is being moved. A warning device should be sounded (if provided) when raising, lowering, or moving loads wherever people are working to make them aware that a load is being moved. Additional warning devices can be used in high-traffic areas.

6. Lifts should not be attempted beyond the rated load capacity of the crane, sling chains, rope slings, etc.

7. If limit switches are out of order or if ropes show defects or wear, the crane should not be operated.

8. Before moving a load, load slings, load chains, or other load lifting devices must be fully seated in the saddle of the hook.

9. When a duplex hook (double saddle hook) is used, a double sling or choker should be used to assure that the load is equally divided over both saddles of the hook.

10. On all capacity or near-capacity loads, the hoist brakes should be tested by returning the master switch or pushbutton to the OFF position after raising the load a few inches off the floor. If the hoist brakes do not hold, the load should be set on the floor and the crane not operated. The defect should be reported immediately to the supervisor.

11. The load should be checked to be certain that it is lifted high enough to clear all obstructions and personnel when moving the bridge or trolley.

12. At no time should a load be held suspended from the crane unless the operator is at the master switches or pushbutton with the power on, and under this condition, the load should be kept as close as possible to the floor to minimize the possibility of an injury if the load should drop.

13. When a hitcher is used, it is the joint responsibility of the crane operator and the hitcher to see that hitches are secure and that all loose material has been removed from the load before starting a lift.

14. Sling hooks hanging loose should not be used to lift loads. (If sling hooks are not needed, they should be properly stored.)

15. All slings or ropes should be removed from the crane hooks when not in use. (Dangling slings or hooks hung in sling rings can inadvertently snag other objects when moving the crane.)

16. Crane operators should not use limit switches to stop the hoist under normal operating conditions. (These are emergency devices and are not to be used as operating controls.)

17. Limit switches should not be blocked, adjusted, or disconnected in order to go higher than the switch will allow.

18. Upper limit switches (and lower limit switches, when provided) should be tested in stopping the hoist at the beginning of each shift, or as frequently as may be directed.

19. Loads must never be moved over anyone, especially loads carried by magnets or vacuum devices. Loads, or parts of loads, held magnetically may drop. Failure of power to magnets or vacuum devices will result in dropping the load unless a backup power supply is furnished.

20. Loads must never be carried over people.

21. If the electric power is disrupted, the controllers must be placed in the OFF position and kept there until power is again available.

22. Before closing main or emergency switches, all controllers must be in the OFF position before reversing - except to avoid accidents. (A slight pause is necessary to give the braking mechanism time to operate.)

23. If plugging protection is not provided, the controllers must always be stopped momentarily in the OFF position before reversing - except to avoid accidents. (A slight pause is necessary to give the braking mechanism time to operate.)

24. Before leaving a crane, the operator should perform the following:

    (a) Raise all hooks to an intermediate position.
    (b) Spot the crane at an approved designated location.
    (c) Place all controls in the OFF position.
    (d) Open the main switch to the OFF position.
    (e) Make visual check before leaving the crane.

    Note: On yard cranes (cranes on outside runways), operators should set the brake and anchor securely so the crane will not be moved by the wind.

25. When two or more cranes are used in making one lift, it is very important that the crane operators take signals from only one designated person.

26. An attempt should never be made to close a switch that has an OUT OF ORDER or DO NOT OPERATE card on it. It is necessary to make a careful check to determine that no one else is working on the crane, before removing the card.

27. In case of emergency or during inspection, repairing, cleaning or lubricating, a warning sign or signal should be displayed and the main switch should be locked in the OFF position. This procedure should be followed whether the work is being done by the crane operator or by others. On cab-operated cranes when others are doing the work, the crane operator should remain in the crane cab unless otherwise instructed by the supervisor.

28. A crane should never move or bump another crane that has a warning sign signal displayed. Contacts with runway stops or other cranes shall be made with extreme caution. The operator must take particular care for the safety of persons on or below the crane, and only after making certain that any persons on the other cranes are aware of what is being done.

29. Fuse sizes should not be changed. Do not attempt to repair electrical apparatus or make other major repairs on the crane unless specific authorization has been received.

30. Electrical limit switches or warning devices should never be bypassed.

31. Load limit or overload devices must not be used to measure loads being lifted. This is an emergency device and is not to be used as a production operating control.

GENERAL MAINTENANCE SAFETY RULES

These rules are taken from *ANSI Standard Safety Code for Overhead and Gantry Cranes*, B30.2.0:

1. To be repaired, a crane must be moved to a location where there will be minimum interference with other cranes and operations in the area.

2. All controllers should be in the OFF position.

3. The main power source should be disconnected, de-energized and locked, tagged, or flagged in the de-energized position.

4. WARNING or OUT OF ORDER signs should be placed on the crane, on the floor beneath, or on the hook where they are visible from the floor.

5. If other cranes are in operation on the same runway, rail stops or other suitable devices shall be provided to protect the idle crane.

6. Where rail stops or other devices are not available or practical, a person should be located where he can warn the operator by reaching the limit of safe distance from the idle crane.

7. Where there are adjacent craneways and the repair area is not protected by wire mesh or other suitable protection, or if any hazard from adjacent operations exists, the adjacent runway must also be restricted. A signaler shall be provided when cranes on the adjacent runway pass the work area. Cranes shall come to a full stop and may proceed through the area on being given a signal from the designated person.

8. Trained personnel shall be provided to work on energized equipment when adjustments and tests are required.

9. After all repairs have been completed, guards shall be reinstalled, safety devices reactivated, and maintenance equipment removed before restoring crane to service.

SOURCE: National Safety Council, 1980. Accident Prevention Manual for Industrial Operations, Engineering and Technology, 8th Edition.

PORTABLE HAND AND POWER TOOLS

HAND TOOLS

Hand tools are non-powered. They include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

Some examples:

- Using a chisel as a screwdriver may cause the tip of the chisel to break and fly, hitting the user or other employees.
- If a wooden handle on a tool such as a hammer or an ax is loose, splintered, or cracked, the head of the tool may fly off and strike the user or another worker.
- A wrench must not be used if its jaws are sprung because it might slip.
- Impact tools such as chisels, wedges, or drift pins are unsafe if they have mushroomed heads. The heads might shatter on impact, sending sharp fragments flying.

The employer is responsible for the safe condition of tools and equipment used by employees, but the employees have the responsibility for using and maintaining tools properly.

Employers should caution employees that saw blades, knives, or other tools be directed away from aisle areas and other employees working in close proximity. Knives and scissors must be sharp. Dull tools can be more hazardous than sharp ones.

When employees are working with hand knives, boning knives, draw knives, and scissors, they should use personal protective equipment such as wire mesh gloves, wrist guards, arm guards, and aprons or belly guards.

Safety requires that floors be kept as clean and dry as possible to prevent accidental slips with or around dangerous hand tools.

Around flammable substances, sparks produced by iron or steel hand tools can be a dangerous ignition source. Where this hazard exists, spark-resistant tools made from brass, plastic, aluminum, or wood will provide safety.

POWER TOOL PRECAUTIONS

Power tools can be hazardous when improperly used. There are several types of power tools, based on the power source they use: electric, pneumatic, liquid fuel, hydraulic, and powder-actuated.

Employees should be trained in the use of all tools—not only power tools. They should understand potential hazards and safety precautions to prevent those hazards from occurring.

The following general precautions should be observed by power tool users:

- Never carry a tool by the cord or hose
- Never yank the cord or the hose to disconnect from the receptacle
- Keep cords and hoses away from heat, oil, and sharp edges
- Disconnect tools when not in use, before servicing, and when changing accessories such as blades, bits, and clutters
- Keep all observers at a safe distance from the work area
- Secure work with clamps or a vise, freeing both hands to operate the tool
- Avoid accidental starting.. The worker should not hold a finger on the switch button while carrying a plugged-in tool
- Maintain tools with care. They should be kept sharp and clean for the best performance. Follow instructions in the user's manual for lubricating and changing accessories
- Be sure to keep good footing and maintain good balance
- Wear proper apparel. Loose clothing, ties, or jewelry can become caught in moving parts
- Remove all portable electric tools and tag with "Do Not Use"

GUARDS

Hazardous moving parts of a power tool need to be safeguarded. For example, belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating, or moving parts of equipment must be guarded if such parts are exposed to contact by employees.

Guards, as necessary, should be provided to protect the operator and others from

- point of operation,
- in-running nip points,
- rotating parts, and
- flying chips and sparks.

Safety guards must never be removed when the tool is being used. For example, portable circular saws must be equipped with guards. An upper guard must cover the entire blade of the saw. A retractable lower guard must cover the teeth of the saw, except when it makes contact with the work material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work.

SAFETY SWITCHES

The following hand-held powered tools must be equipped with a momentary contact "on-off" control switch: drills, tappers, fastener drivers, horizontal, vertical and angle grinders with wheels larger than two inches in diameter, disc sanders, belt sanders, reciprocating saws, saber saws, and other similar operations. These tools may also be equipped with a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

The following hand-held powered tools may be equipped with only a positive "on-off" control switch: platen sanders, grinders with wheels two inches or less in diameter, routers, planers, laminate trimmers, nibblers, shears, scroll saws and jigsaws with blade shanks one-fourth inch wide or less.

Other hand-held powered tools such as circular saws, chain saws, and percussion tools without positive accessory holding means must be equipped with a constant pressure switch that will shut off the power when the pressure is released.

ELECTRIC TOOLS

Employees using electric tools must be aware of several dangers; the most serious is the possibility of electrocution.

Among the chief hazards of electric-powered tools are burns and slight shocks which can lead to injuries or even heart failure. Under certain conditions, even a small amount of current can result in fibrillation of the heart and eventual death. A shock also can cause the user to fall off a ladder or other elevated work surface.

To protect the use from shock, tools must either have a three-wire cord with ground and be grounded, be double insulated, or be powered by a low-voltage isolation transformer. Three-wire cords contain two current-carrying conductors and a grounding conductor. One end of the grounding conductor connects to the tool's metal housing. The other end is grounded through a prong on the plug. Anytime an adapter is used to accommodate a two-hole receptacle, the adapter wire must b attached to a known ground. The third prong should never be removed from the plug.

Double insulation is more convenient. The user and the tools are protected in two ways: by normal insulation on the wires inside and by a housing that cannot conduct electricity to the operator in the event of a malfunction.

The following general practices should be followed when using electric tools:

- Electric tools should be operated within their design limitations.
- Gloves and safe footwear are recommended during use of electric tools.
- Tools not in use should be stored in a dry place.
- Electric tools should not be used in damp or wet locations.
- Work areas should be well lighted.

POWER ABRASIVE WHEEL TOOLS

Powered abrasive grinding, cutting, polishing, and wire buffing wheels create special safety problems because they may throw off flying fragments.

Before an abrasive wheel is mounted, it should be inspected closely and sound or ring-tested to be sure that it is free from cracks or defects. To test, wheels should be tapped gently with light non-metallic implement. If they sound cracked or dead, they could fly apart in operation and so must not be used. A sound or undamaged wheel will give a clear metallic tone or "ring."

To prevent the wheel from cracking, the user should be sure it fits freely on the spindle. The spindle nut must be tightened enough to hold the wheel in place, but not tight enough to distort the flange. Follow the manufacturer's recommendations. Care must be taken to assure that the spindle wheel will not exceed the abrasive wheel specifications.

Due to the possibility of a wheel disintegrating (exploding) during start-up, the employee should never stand directly in front of the wheel as it accelerates to full operating speed.

Portable grinding tools need to be equipped with safety guards to protect workers, not only from the moving wheel surface but also from flying fragments in case of breakage.

In addition, the following rules should be followed when using a powered grinder:

- Always use eye protection
- Turn off the power when not use
- Never clamp a hand-held grinder in a vise

PNEUMATIC TOOLS

Pneumatic tools are powered by compressed air; they include chippers, drills, hammers, and sanders.

There are several dangers encountered in the use of pneumatic tools. The main one is the danger of getting wet by one of the tool's attachments or some kind of fastener the worker is using with the tool.

Pneumatic tools that shoot nails, rivets, or staples, and operate at more than 100 pounds per square inch, must be equipped with a special device to keep fasteners from being ejected unless the muzzle is pressed against the work surface.

Eye protection is required and face protection is recommended for employees working with pneumatic tools.

Noise is another hazard. Working with noisy tools such as jackhammers requires proper, effective use of ear protection. (For more information on noise, see OSHA publication 3074, Hearing Conservation.)

When using pneumatic tools, employees must check to see that they are fastened securely to me hose by a positive means to prevent them from becoming disconnected. A short wire or positive locking device attaching the air hose to the tool will serve as an added safeguard.

Airless spray guns which atomize paints and fluids at high pressures (1,000 pounds or more per square inch) must be quipped with automatic or visual manual safety devices which will prevent pulling the trigger until the safety device is manually released.

If an air hose is more than one-half inch in diameter, a safety excess flow valve must be installed at the source of the air supply to shut off the air automatically in case the hose breaks.

In general, the same precautions should be taken with an air hose that are recommended for electric cords, because the hose is subject to the same kind of damage or accidental striking and presents tripping hazards.

A safety clip or retainer must be installed to prevent attachments, such as chisels on a chipping hammer, from being unintentionally shot from the barrel.

Screens must be set up to protect nearby workers from being struck by flying fragments around chippers, riveting guns, staplers, or aid drills.

Compressed air guns should never be pointed toward anyone. The user should never "dead-end" it against him or herself or anyone else.

Heavy jackhammers can cause fatigue and strains; heavy rubber grips reduce these effects by providing a secure handhold.

Workers operating a jackhammer must wear safety glasses and safety shoes, which protect against injury if the hammer slips of falls. A face shield should also be sued.

LIQUID-FUEL TOOLS

A third type of tool is fuel-powered, usually by gasoline. The most serious hazard with fuel-powered tools comes from fuel vapors that can burn or explode and give off dangerous exhaust fumes.

The worker must be careful handling, transporting, and storing the gas or fuel in approved flammable liquid containers, according to proper procedures for flammable liquids.

Before the tank for a fuel-powered tool is refilled the user must shut the engine down and allow it to cool to prevent accidental igniting of hazardous vapors.

If a fuel-powered tool is used inside a closed area, effective ventilation and/or personal protective equipment is necessary to avoid breathing carbon monoxide. Fire extinguishers must be available in the area.

POWDER-ACTUATED TOOLS

Powder-actuated tools operate like a loaded gun and should be treated with the same respect and precautions. In fact, they are so dangerous that they must be operated only by specially trained employees.

These are safety precautions to remember:

- These tools should not be used in an explosive or flammable atmosphere.
- Before using the tool, the worker should inspect it to determine that it is clean, that all moving parts operate freely, and that the barrel is free from obstructions.
- The tool should never be pointed at anybody.
- The tool should not be loaded unless it is to be used immediately. A loaded tool should not be left unattended, especially where it would be available to unauthorized persons.
- Hands should be kept clear of the barrel end. To prevent the tool from firing accidentally, two separate motions are required for firing: one to bring the tool into position and another to pull the trigger. The tools must not be able to operate until they are pressed against the work surface with a force of at least five pounds greater than the total weight of the tool.

If a powder-actuated tool misfires, the employee should wait at least 30 seconds, then try firing it again. If it still will not fire, the user should wait another 30 seconds so that the faulty cartridge is less likely to explode, then carefully remove the load. The bad cartridge should be put in water.

Suitable eye and face protection are essential when using a powder-actuated tool.

The muzzle end of the tool must have a protective shield or guard centered perpendicularly on the barrel to confine any flying fragments or particles which might otherwise create a hazard when the tool is fired. The tool must be designed so that it will not fire unless it has this kind of safety device.

All powder-activated tools must be designed for varying powder charges to that the user can select a powder level necessary to do the work without excessive force.

If the tool develops a defect during use it should be tagged and taken out of service immediately until it is properly repaired.

FASTENERS

When using powder-actuated tools to apply fasteners there are some precautions to consider. Fasteners must not be fired into material which would let them pass through to the other side. The fastener must not be driven into materials like brick or concrete any closer than three inches to an edge or corner. In steel, the fastener must not come closer than a half inch from a corner or edge. Fasteners must not be driven into very hard or brittle materials which might chip or splatter, or make the fastener ricochet.

An alignment guide must be used when shooting a fastener into an existing hole. A fastener must not be drive into a spalled area caused by an unsatisfactory fastening.

HYDRAULIC POWER TOOLS

The fluid used in hydraulic power tools must be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperature to which it will be exposed.

The manufacturer's recommended safe operating pressure for hoses, valve, pipes, filters, and other fittings must not be exceeded.

JACKS

All jacks — level and rachel jacks, screw jacks, and hydraulic jacks — must have a device which stops them from jacking up to high. Also, the manufacturer's load limit must be permanently marked in a prominent place on the jack and should not be exceeded.

A jack should never be used to support a lifted load. Once the load has been lifted, it must immediately be blocked up. Use wooden blocking under the base if necessary to make the jack level and secure. If the lift surface is metal, place a one-inch thick hardwood block or equivalent between it and the metal jack head to reduce the danger of slippage.

To set up a jack, be sure that

- The base rests on a firm level surface,
- The jack is correctly centered,
- The jack head bears against a level surface, and
- The lift force is applied squarely.

Proper maintenance of jacks is essential for safety. All jacks must be inspected before each use and lubricated regularly. If a jack is subjected to an abnormal load or shock, it should be thoroughly examined to make sure it has not been damaged.

jacks exposed to freezing temperatures must be filled with an adequate antifreeze liquid.

GENERAL SAFETY PRECAUTIONS

Employees using hand and power tools and exposed to the hazard of falling, flying, abrasive and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases must be provided with the particular personal equipment necessary to protect them from the hazard.

All hazards involved in the use of power tools can be prevented by following five basic safety rules:

- Keep all tools in good condition with regular maintenance.
- Use the right tool for the job.
- Examine each tool for damage before use.
- Operate according to the manufacturer's instructions.
- Provide and use the right protective equipment.

Employees and employers have a responsibility to work together to establish safe working procedures. If a hazardous situation is encountered, it should be brought to the attention of the proper individual immediately.

SOURCE: OSHA, 1986. Booklet No. 3080

WELDING HEALTH HAZARDS

I. CHEMICAL AGENTS

Zinc — Zinc is used in large quantities in the manufacture of brass, galvanized metals, and various other alloys. Inhalation of zinc oxide fumes can occur when welding or cutting on zinc-coated metals. Exposure to these fumes is known to cause metal fume fever. Symptoms of metal fume fever are very similar to those of common influenza. They include fever (rarely exceeding 102° F), chills, nausea, dryness of the throat, cough, fatigue, and general weakness and aching of the head and body. The victim may sweat profusely for a few hours, after which the body temperature begins to return to normal. The symptoms of metal fume fever have rarely, if ever, lasted beyond 24 hours. The subject can then appear to be more susceptible to the onset of this condition on Mondays or on weekdays following a holiday than they are on other days.

Cadmium — Cadmium is used frequently as a rust-preventive coating on steel and also as an alloying element. Acute exposures to high concentrations or cadmium fumes can produce severe lung irritation, pulmonary edema, and in some cases, death. Long-term exposure to low levels of cadmium in air can result in emphysema (a disease affecting the ability of the lung to absorb oxygen) and can damage the kidneys.

Beryllium — Beryllium is sometimes used as an alloying element with copper and other base metals. Acute exposure to high concentrations of beryllium can result in chemical pneumonia. Long-term exposure can result in shortness of breath, chronic cough, and significant weight loss, accompanied by fatigue and general weakness.

Iron Oxide — Iron is the principal alloying element in steel manufacture. During the welding process, iron oxide fumes arise from both the base metal and the electrode. The primary acute effect of this exposure is irritation of nasal passages, throat, and lungs. Although long-term exposure to iron oxide fumes may result in iron pigmentation of the lungs, most authorities agree that these iron deposits in the lung are not dangerous.

Mercury — Mercury compounds are used to coat metals to prevent rust or inhibit foliage growth (marine paints). Under the intense heat of the arc or gas flame, mercury vapors will be produced. Exposure to these vapors may produce stomach pain, diarrhea, kidney damage, or respiratory failure. Long-term exposure may produce tremors, emotional instability, and hearing damage.

Lead — The welding and cutting of lead-bearing allows or metals whose surfaces have been painted with lead-based paint can generate lead oxide fumes. Inhalation and ingestion of lead oxide fumes and other lead compounds will cause lead poisoning. Symptoms include metallic taste in the mouth, loss of appetite, nausea, abdominal cramps, and insomnia. In time, anemia and general weakness, chiefly in the muscles of the wrists, develop. Lead adversely affects the brain, central nervous system, circulatory system, reproductive system, kidneys, and muscles.

Fluorides — Fluoride compounds are found in the coatings of several types of fluxes used in welding. Exposure to these fluxes may irritate the eyes, nose, and throat. repeated exposure to high concentrations of fluorides in air over a long period may cause pulmonary edema (fluid in the lungs) and bone damage. Exposure to fluoride dusts and fumes has also produced skin rashes.

Chlorinated Hydrocarbon Solvents — Various chlorinated hydrocarbons are used in degreasing or other cleaning operations. The vapors of these solvents are a concern in welding and cutting because the heat and ultraviolet radiation from the arc will decompose the vapors and form highly toxic and irritating phosgene gas. (See Phosgene)

Phosgene — Phosgene is formed by decomposition of chlorinated hydrocarbon solvents by ultraviolet radiation. It reacts with moisture in the lungs to produce hydrogen chloride, which in turn destroys lung tissue. For this reason, any use of chlorinated solvents should be well away from welding operations or any operation in which ultraviolet radiation or intense heat is generated.

Carbon Monoxide — Carbon monoxide is a gas usually formed by the incomplete combustion of various fuels. Welding and cutting may produce significant amounts of carbon monoxide. In addition, welding operations that use carbon dioxide as the inert gas shield may produce hazardous concentrations of carbon monoxide in poorly ventilated areas. This is caused by a "breakdown" of shielding gas. Carbon monoxide is odorless and colorless and cannot be detected. Common symptoms of overexposure include pounding of the heart, a dull headache, flashes before the eyes, dizziness, ringing in the ears, and nausea.

Nitrogen Oxides — The ultraviolet light of the arc can produce nitrogen oxides (NO,NO_2), from the nitrogen (N) and Oxygen (O_2) in the air. Nitrogen oxides are produced by gas metal arc welding (GMAW or short-arc), gas tungsten arc welding (GMAW or heli-arc), and plasma arc cutting. Even greater quantities are formed if the shielding gas contains nitrogen. Nitrogen dioxide (NO_2), one of the oxides formed, has the greatest health effect. This gas is irritating to the eyes, nose, and throat but dangerous concentrations can be inhaled without any immediate discomfort. High concentrations can cause shortness of breath, chest pain, and fluid in the lungs (pulmonary edema).

Ozone — Ozone (O_3) is produced by ultraviolet light from the welding arc. Ozone is produced in greater quantities by gas metal arc welding (GMAW or short-arc), gas tungsten arc welding (GMAW or heli-arc), and plasma arc cutting. Ozone is a highly active form of oxygen and can cause great irritation to all mucous membranes. Symptoms of ozone exposure include headache, chest pain, and dryness of the upper respiratory tract. Excessive exposure can cause fluid in the lungs (pulmonary edema). Both nitrogen dioxide and ozone are thought to have long-term effects on the lungs.

II. PHYSICAL AGENTS

Ultraviolet Radiation — Ultraviolet radiation (UV) is generated by the electric arc in the welding process. Skin exposure to UV can result in severe burns, in many cases without prior warning. UV radiation can also damage the lens of the eye. Many arc welders are aware of the condition known as "arc-eye," a sensation of sand in the eyes. This condition is caused by excessive eye exposure to UV. Ultraviolet rays also increase the skin effects of some industrial chemicals (coal tar and cresol compounds, for example).

Infrared Radiation — Exposure to infrared radiation (IR), produced by the electric arc and other flame cutting equipment may heat the skin surface and the tissues immediately below the surface. Except for this effect, which can progress to thermal burns in some situations, infrared radiation is not dangerous to welders. Most welders protect themselves from IR (and UV) with a welder's helmet (or glasses) and protective clothing.

Intense Visible Light — Exposure of the human eye to intense visible light can produce adaptation, pupillary reflex, and shading of the eyes. Such actions are protective mechanisms to prevent excessive light from being focused on the retina. In the arc welding process, eye exposure to intense visible light is prevented for the most part by the welder's helmet. However, some individuals have sustained retinal damage due to careless "viewing" of the arc. At no time should the arc be observed without eye protection.

FILTER LENS SHADE NUMBER GUIDE

Welding Operation	Shade Number
Shielded Metal-Arc Welding, up to 5/32" (4mm) electrodes	10
Shielded Metal-Arc Welding, 3/16 to 1/4" (4.8 to 6.5mm) electrodes	12
Shielded Metal-Arc Welding, over 1/4" (6.4mm) electrodes	14
Gas Metal-Arc Welding (Nonferrous)	11
Gas Metal-Arc Welding (Ferrous)	12
Gas Tungsten-Arc Welding	12
Atomic Hydrogen Welding	14
Carbon Arc Welding	10-14
Torch Soldering	2
Torch Brazing	3 or 4
Light Cutting, up to 1" (25mm)	3 or 4
Medium Cutting, 1" to 6" (25 to 150mm)	4 or 5
Heavy Cutting, over 6" (150mm)	5 or 6
Gas Welding (light), up to 1/8" (3.2mm)	4 or 5
Gas Welding (medium), 1/8" to 1/2" (3.2 to 12.7mm)	5 or 6
Gas Welding (heavy), over 1/2" in (12.7mm)	6 or 8

In gas welding or oxygen cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the operation spectrum.

SOURCE: OSHA

WELDING, CUTTING, AND BRAZING

INTRODUCTION

Many welding and cutting operations require the use of compressed gases. When compressed gases are consumed in the welding process, such as oxygen-fuel gas welding, requirements for their handling, storage, and use are contained in 29 CFR, Subpart O.

General requirements for the handling, storage and use of compressed gases are contained in 29 CFR, Subpart H-Hazardous Materials, §§1910.101 - 1910.105. Certain welding and cutting operations require the use of compressed gases other than those consumed in the welding process. For example, gas metal arc welding utilizes compressed gases for shielding. Handling, storage, and use of compressed gases in situations such as these requires compliance with the requirements contained in 29 CFR, Subpart H.

Many hazards are involved in compressed gas handling, storage, and use. To understand these hazards, we must realize that compressed gases are stores of potential energy. It takes energy to compress and confine the gas. That energy is stored until purposely released to perform useful work or until accidental release by container failure or other causes.

Some compressed gases, for example, acetylene, have high flammability characteristics. Flammable compressed gases, therefore, have additional stored energy besides simple compression-release energy. Other compressed gases, such as nitrogen, have simple asphyxiating properties. Some compressed gases, such as oxygen, can augment or compound fire hazards.

COMPRESSED GASES

Cylinder Inspection — Employers shall determine that compressed gas cylinders under their control are in a safe condition to the extent that this can be determined by visual inspection. Visual and "other" inspections are required, but "other" inspections are not defined. These inspections must be conducted as prescribed in the Hazardous Materials Regulations of the Department of Transportation (DOT) contained in 49 CFR Parts 171-179 and 14 CFR Part 103. Where these regulations are not applicable, these inspections shall be conducted in accordance with Compressed Gas Association (CGA) Pamphlets C-6 and C-8. According to DOT regulations:

> "A cylinder that leaks, is bulged, has defective valves or safety devices, bears evidence of physical abuse, fire or heat damage, or detrimental rusting or corrosion, must not be used unless it is properly repaired and requalified as prescribed in these regulations."

The term "cylinder" is defined as a pressure vessel designed for pressures higher than 40 psia (pounds per square inch absolute) and having a circular cross section. It does not include a portable tank, multiunit tank car tank, cargo tank, or tank car.

DOT requires basic information markings on all cylinders. Each required marking on a cylinder must be maintained so that it is legible.

Handling, Storage, and Utilization — The handling storage, and utilization of all compressed gases in cylinders, portable tanks, rail tankcars, or motor vehicle cargo tanks shall be in accordance with Compressed Gas Association (CGA) Pamphlet P-1.

Safety Relief Devices — Compressed gas cylinders, portable tanks, and cargo tanks shall have pressure relief devices installed and maintained in accordance with CGA Pamphlets S-1.1 and S-1.2.

FIRE PREVENTION AND PROTECTION

Basic Precautions — The basic precautions for fire prevention in welding or cutting work are:

- If the object to be welded or cut cannot readily be moved, all movable fire hazards in the vicinity shall be taken to a safe place.

- If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks, and slag, and to protect the immovable fire hazards.

- If the above requirements cannot be met, then welding and cutting shall not be performed.

Special Precautions — Suitable fire extinguishing equipment shall be maintained in a state of readiness for instant use. Such equipment may consist of pails of water, buckets of sand, hose or portable extinguishers depending upon the nature and quantity of the combustible material exposed.

Fire watchers are required whenever welding or cutting is performed in locations where other than a minor fire might develop, or any of the following conditions exist:

- Appreciable combustible materials, in building construction or contents, closer than 35 feet to the point of operation.

- Appreciable combustibles more than 35 feet away but are easily ignited by sparks.

A fire watch shall be maintained for at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires.

Cutting or welding shall not be permitted in e following situations:

- In areas not authorized by management

- In sprinklered buildings while such protection is impaired

- In the presence of explosive atmospheres (mixtures of flammable gases, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts.

Welding or Cutting Containers — No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks, or other containers until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substances such as greases, tars, acids, or other materials which when subjected to heat, might produce flammable or toxic vapors. Any pipe lines or connections to the drum or vessel shall be disconnected or blanked.

Confined Spaces — When arc welding is to be suspended for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine shall be disconnected from the power source.

In order to eliminate the possibility of gas escaping through leaks or improperly closed valves, when gas welding or cutting, the torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch hour or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

PROTECTION OF PERSONNEL

General — A welder or helper working on platforms, scaffolds, or runways shall be protected against falling through the use of railings, safety belts, life lines, or some equally effective safeguards.

Eye Protection — Helmets or hand shields shall be used during all arc welding or arc cutting operations, excluding submerged arc welding. Helpers or attendants shall be provided with proper eye protection.

Helmets and hand shields shall be made of a material which is in insulator for heat and electricity. Helmets, shields and goggles shall not be readily flammable and shall be capable of withstanding sterilization.

Helmets and hand shields shall be arranged to protect the face, neck, and ears from direct radiant energy from the arc.

Where the work permits, the welder should be enclosed in an individual booth painted with a finish of low reflectivity such as zinc oxide (an important factor for absorbing ultra-violet radiations) and lamp black, or shall be enclosed with non-combustible screens similarly painted. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by non-combustible or flameproof screens or shields or shall be required to wear appropriate goggles.

Protective Clothing — Employees exposed to the hazards created by welding, cutting, or brazing operations shall be protected by personal protective equipment in accordance with the requirements of §1910.132. Appropriate protective clothing required for any welding operation will vary with the size, nature, and location of the work to be performed. Welders should always select clothing materials which will provide maximum protection from sparks and hot metal. Protective eyewear, safety shoes, clean, fire-resistant clothing, and fire-resistant gauntlet gloves are recommended. Additionally, the shirt should have full sleeves, no pockets, and should be worn outside the trousers with collar buttoned. The trousers should have no cuffs and should extend well down to the safety shoes.

Work in Confined Spaces — A confined space is defined in this regulation to be a relatively small or restricted space such as a tank, boiler, pressure vessel, or small compartment of a ship.

Adequate ventilation is a prerequisite to work in confined spaces. Ventilation requirements are discussed later in this section.

When welding or cutting is being performed in any confined space, the gas cylinders and welding machines shall be left on the outside.

Where welders must enter a confined space through a manhole or other small opening, means shall be provided for quickly removing them in case of emergency. An attendant with a pre-planned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect.

When arc welding is to be suspended for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine disconnected from the power source.

In order to eliminate the possibility of gas escaping through leaks of improperly closed valves, when gas welding or cutting, the torch valves shall be closed and the fuel-gas and oxygen supply to the torch positively shut off at some point outside the confined area whenever the torch is not to be used for a substantial period of time, such as during lunch or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

HEALTH PROTECTION AND VENTILATION

Mechanical ventilation is required when welding or cutting is done with materials not specifically mentioned in this section. These materials - fluorine compounds, zinc, lead, beryllium, cadmium, mercury, cleaning compounds, and stainless steel are particularly hazardous and have specific control requirements.

SOURCE: OSHA

CONTROLLING ELECTRICAL HAZARDS

INTRODUCTION

Electricity has become an essential of modern life, both at home and on the job. Some employees work with electricity directly, as is the case with engineers, electricians, or people who do wiring, such as overhead lines, cable harnesses, or circuit assemblies. Others, such as office workers and salespeople, work with it indirectly. As a source of power, electricity is accepted without much thought to the hazards encountered. Perhaps because it has become such a familiar part of our surroundings, it often is not treated with the respect it deserves.

For 1980, the Bureau of Labor Statistics reports that 4,400 work-connected deaths occurred in private sector workplaces employing 11 workers or more. The total number of job-related injuries for that same period was roughly 5.5 million. One-tenth of one percent of all accidents, or about 2,500 injuries, were due to various degrees of electrical shock. Eight percent of the fatalities, or around 350 deaths, were the direct result of electrocutions at work. What makes these statistics more tragic is that, for the most part, these accidents and fatalities could have been easily avoided.

How Does Electricity Act?

To handle electricity safely, it is necessary to understand how it acts, how it can be directed, what hazards it presents, and how these hazards can be controlled. For this purpose it is helpful to compare the flow of electricity with the flow of water.

Operating an electrical switch may be considered analogous to turning on a water faucet. Back of the faucet or the switch there must be a source of water or electricity, with something in which to transport it, and with pressure to make it flow. In the case of water, the source is a reservoir or pumping station; the transportation is through pipes; and the force to make it flow is pressure, provided by a pump. In electricity, the source is the power generating station; current travels (is transported) through electrical conductors in the form of wires; and pressure, measured in volts, is provided by a generator.

Resistance to the flow of electricity is measured in ohms and varies widely. It is determined by three factors: the nature of the substance itself; the length and cross-sectional area (size) of the substance; and the temperature of the substance.

Some substances, such as metals, offer very little resistance to the flow of electrical current and are called conductors. Other substances, such as bakelite, porcelain, pottery, and dry wood, offer such a high resistance that they can be used to prevent the flow of electrical current and are called insulators.

Dry wood has a high resistance, but when saturated with water its resistance drops to the point where it will readily conduct electricity. The same thing is true of human skin. When it is dry, skin has a fairly high resistance to electrical current; but when it is moist, there is a radical drop in resistance. Pure water is a poor conductor, but small amounts of impurities, such as salt and/or acid (both of which are contained in perspiration), make it a ready conductor. Therefore, when water is present either in the environment or on the skin, anyone working with electricity should exercise even more caution than they normally would.

How Shocks Occur

Electricity travels in closed circuits, and its normal route is through a conductor. Shock occurs when the body becomes a part of the electrical circuit. The current must enter the body at one point and leave at another. Shock normally occurs in one of three ways. The person must come in contact with: both wires of the electrical circuit; one wire of an energized circuit and the ground; or a metallic part that has become "hot" by being in contact with an energized wire, while the person is also in contact with the ground.

The metal parts of electrical tools and machines may become "hot" if there is a break in the insulation of the tool or machine wiring. The worker using these tools and machines is made less vulnerable to electrical shock when a low-resistance path from the metallic case of the tool or machine to the ground is established. This is done through the use of an equipment grounding conductor—a low-resistance wire that causes the unwanted current to pass directly to the ground rather than through the body of the person in contact with the tool or machine. If the equipment grounding conductor has been properly installed, it has a low resistance to ground, and the worker is being protected.

Severity of the Shock

The severity of the shock received when a person becomes a part of an electrical circuit is affected by three primary factors: the amount of current flowing through the body (measured in amperes); the path of the current through the body; and the length of time the body is in the circuit. Other factors which may affect the severity of shock are the frequency of the current, the phase of the heart cycle when shock occurs, and the general health of the person prior to shock.

The effects from electric shock depend upon the type of circuit, its voltage, resistance, amperage, pathway through the body, and duration of the contact. Effects can range from a barely perceptible tingle to immediate cardiac arrest. Although there are no absolute limits or even known values which show the exact injury from any given amperage, the following table shows the general relationship between the degree of injury and amount of amperage for a 60-cycle hand-to-foot path of one second's duration of shock.

EFFECTS OF ELECTRICAL CURRENT IN THE HUMAN BODY

Current	Reaction
1 Milliampere	Perception level. Just a faint tingle.
5 Milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. However, strong involuntary reactions to shocks in this range can lead to injuries.
6-25 Milliamperes (women) 9-30 Milliamperes (men)	Painful shock, muscular control is lost. This is called the freezing current or "let-go" range.
50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular contractions[(a)]. Individual cannot let go. Death is possible.
1,000-4300 Milliamperes	Ventricular fibrillation. (The rhythmic pumping action of the heart ceases.) Muscular contraction and nerve damage occur. Death is most likely.
10,000 Milliamperes	Cardiac arrest, severe burns and probable death.

(a) If the extensor muscles are excited by the shock, the person may be thrown away from the circuit.

As this table illustrates, a difference of less than 100 milliamperes exists between a current that is barely perceptible and one that can kill. Muscular contraction caused by stimulation may not allow the victim to free himself/herself from the circuit, and the increased duration of exposure increases the dangers to the shock victim. For example, a current of 100 milliamperes for 3 seconds is equivalent to a current of 900 milliamperes applied for .03 seconds in causing fibrillation. The so-called low voltages can be extremely dangerous because, all other factors being equal, the degree of injury is proportional to the length of time the body is in the circuit. LOW VOLTAGE DOES NOT IMPLY LOW HAZARD.

Burns and Other Injuries

A severe shock can cause considerably more damage to the body than is visible. There may be internal hemorrhages and destruction of tissues, nerves, and muscles. In addition, shock is often only the beginning in a chain of events. The final injury may well be from a fall, cuts, burns, or broken bones.

The most common shock-related injury is a burn. Burns suffered in electrical accidents may be of three types: electrical burns, arc burns, and thermal contact burns.

Electrical burns are a result of the electrical current flowing through tissues or bones. Tissue damage is caused by the heat generated by the current flow through the body. Electrical burns are one of the most serious injuries you can receive and should be given immediate attention.

Arc or flash burns, on the other hand, are the result of high temperatures in close proximity to the body and are produced by an electric arc or explosion. They should be attended to promptly.

Finally, thermal contact burns are those normally experienced when the skin comes in contact with hot surfaces of overheated electrical conductors, conduits, or other energized equipment. Additionally, clothing may be ignited in an electrical accident and a thermal burn will result. All three types of burns may be produced simultaneously.

Electric shock can also cause injuries of an indirect or secondary nature in which involuntary muscle reaction from the electric shock can cause bruises, bone fractures, and even death resulting from collisions or falls. In some cases, injuries caused by electric shock can be a contributory cause of delayed fatalities.

In addition to shock and burn hazards, electricity poses other dangers. For example, when a short circuit occurs, hazards are created from the resulting arcs. If high current is involved, these arcs can cause injury or start a fire. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. Even low-energy arcs can cause violent explosions in atmospheres which contain explosive gases, vapors, or combustible dusts.

Correcting Electrical Hazards

Electrical accidents appear to be caused by a combination of three possible factors—unsafe equipment and/or installation, workplaces made unsafe by the environment, and unsafe work practices by employees. There are various ways of protecting people from the hazards caused by electricity. These include; insulation, guarding, grounding, mechanical devices, and safe work practices.

Insulation—One way to safeguard individuals from electrically energized wires and parts is through insulation. An insulator is any material with high resistance to electrical current. Insulators—such as glass, mica, rubber, and plastic—are put on conductors to prevent shock, fires, and short circuits. Before employees prepare to work with electrical equipment, it is always a good idea for them to check the insulation before making a connection to a power source to be sure there are no exposed wires. The insulation of electrical cords, such as extension cords, is particularly vulnerable to damage.

The insulation that covers conductors is regulated by Subpart S of 29 CFR Part 1910, "Design Safety Standards for Electrical Systems," as published in the *Federal Register* on January 16, 1981. This standard revises the former Subpart S and places relevant requirements of the National Electrical Code (NEC) directly into the text of the regulations, making it unnecessary for employees to refer to the NEC to determine their obligations and unnecessary for OSHA to continue incorporating the NEC by reference.

The standard generally requires that circuit conductors, the material through which current flows, be insulated to prevent people from coming into accidental contact with the current. Also, the insulation should be suitable for the voltage and existing conditions, such as temperature, moisture, oil, gasoline, or corrosive fumes. All these factors must be evaluated before the proper choice of insulation can be made.

Conductors and cables are marked by the manufacturer to show the maximum voltage and American Wire Gage size, the type letter of the insulation, and the manufacturer's name or trademark.

Insulation is often color coded. In general, insulated wires used as equipment grounding conductors are either continuous green or green with yellow stripes. The grounded conductors which complete a circuit are generally covered with continuous white or natural gray-colored insulation. The ungrounded conductors, or "hot wires," may be any color other than green, white, or gray. They are often colored black or red.

Guarding—Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact. Guarding of live parts may be accomplished by:

- Location in a room, vault, or similar enclosure accessible only to qualified persons
- Use of permanent, substantial partitions or screens to exclude unqualified persons
- Location on a suitable balcony, gallery, or platform elevated and arranged to exclude unqualified persons, or
- Elevation of 8 feet or more above the floor.

Entrances to rooms and other guarded locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons to enter.

Indoor electric installations that are over 600 volts and that are open to unqualified persons must be made with metal-enclosed equipment or enclosed in a vault or area controlled by a lock. In addition, equipment must be marked with appropriate caution signs.

Grounding—Grounding is another method of protecting employees from electric shock; however, it is normally a secondary protective measure. The term "ground" refers to a conductive body, usually the earth. Used as a noun, the term means a conductive connection, whether intentional or accidental, by which an electrical circuit or equipment is connected to earth or ground plane. By "grounding" a tool or electrical system, a low-resistance path to the earth through a ground connection or connections has been intentionally created. When properly done, this path offers sufficiently low resistance and has sufficient current-carrying capacity to prevent the buildup of voltages which may result in a personnel hazard. This does not guarantee that no one will receive a shock, be injured, or be killed. However, it substantially reduces the possibilities of such accidents—especially when used in combination with the other safety measures discussed in this booklet.

There are two kinds of grounds required by "Design Safety Standards for Electrical Systems" (Subpart S). One of these is called the "service or system ground." In this instance, one wire—called "the neutral conductor" or "grounded conductor"—is grounded. In an ordinary low-voltage circuit, the white (or gray) wire is grounded at the generator or transformer and again at the service entrance to the building. This type of ground is primarily designed to protect machines, tools, and insulation against damage.

To offer enhanced protection to the workers themselves, an additional ground, sometimes called the "equipment ground," must be furnished by providing another path from the tool or machine through which the current can flow to the ground. This additional ground safeguards the electrical equipment operator in the event that a malfunction causes the metal frame of the tool to become accidentally energized. The resulting heavy surge of current will then activate the circuit of protection and open the circuit.

Mechanical Devices—Mechanical devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload, or short circuit in the wiring system. Fuses, circuit breakers, and ground-fault circuit interrupters are three well known examples of such devices.

Fuses and circuit-breakers are over-current devices which are placed in circuits to monitor the amount of current the circuit will carry. They automatically open or break the circuit when the amount of current flow becomes excessive and therefore unsafe. Fuses are designed to melt when too much current flows through them. Circuit breakers, on the other hand, are designed to trip open the circuit.

Fuses and circuit breakers are intended primarily for the protection of conductors and equipment. They prevent overheating of wires and components which might otherwise create hazards for other operators. They also open the circuit under certain hazardous ground-fault conditions.

The ground-fault circuit interrupter of GFCI is designed to shut off electrical power within as little as 1/40 of a second. It works by comparing the amount of current going to an electrical device against the amount of current returning from the device along the circuit conductors. The GFCI is used in high-risk areas such as wet locations and construction sites.

Safe Work Practices—Employees and others working with electrical equipment need to use safe work practices. These include: de-energizing electrical equipment before inspecting or making repairs, using electrical tools that are in good repair, using good judgment when working near energized lines, and using appropriate protective equipment.

De-energizing Electrical Equipment. The accidental or unexpected sudden starting of electrical equipment can cause severe injury or death. Before ANY inspections or repairs are made—even on the so-called low-voltage circuits—the current should be turned off at the switch box and the switch be padlocked in the OFF position. At the same time the switch or controls of the machine or other equipment being locked out of service should be securely tagged to show which equipment or circuits are being worked on.

Maintenance employees should be qualified electricians who have been well instructed in lockout procedures. No two locks should be alike; each key should fit only one lock, and only one key should be issued to each maintenance employee. If more than one employee is repairing a piece of equipment, each should lock out the switch with his or her own lock and never permit anyone else to remove it. The maintenance worker should at all times be certain that he or she is not exposing other employees to danger.

Tools. To minimize his or her own safety, an employee should always be sure to use tools that are working properly. Tools should be inspected frequently, and those found questionable, removed from service and properly tagged. Tools and other equipment should be regularly maintained. Inadequate maintenance can cause equipment to deteriorate, resulting in an unsafe condition.

Good Judgment. Perhaps the single most successful defense against electrical accidents is the continuous exercising of good judgment or common sense. All employees should be thoroughly familiar with the safety procedures for their particular jobs. When working around energized lines, for example, some basic procedures are: (1) have the line de-energized, (2) ensure that the line remains de-energized by using some type of lockout/tagging procedure, (3) use insulated work equipment, and (4) keep a safe distance from energized lines.

Protective Equipment. Employees whose occupations require them to work constantly and directly with electricity must use the personal protective equipment required for the jobs they perform. This equipment may consist of rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets.

CONCLUSION

The control of electrical hazards is an important part of every safety and health program. The responsibility for this program should be delegated to individuals who have a complete knowledge of electricity, electrical work practices, and the appropriate OSHA standards for installation and performance.

Everyone has the right to work in a safe environment. Through cooperative efforts, employers and employees can learn to identify and eliminate or control electrical hazards.

SOURCE: OSHA, 1991. Booklet No. 3075

GROUND-FAULT PROTECTION ON CONSTRUCTION SITES

Insulation and Grounding

Insulation and grounding are two recognized means of preventing injury during electrical equipment operation. Conductor insulation may be provided by placing nonconductive material such as plastic around the conductor. Grounding may be achieved through the use of a direct connection to a known ground such as a metal cold water pipe.

Consider, for example, the metal housing or enclosure around a motor or the metal box in which electrical switches, circuit breakers, and controls are placed. Such enclosures protect the equipment from dirt and moisture and prevent accidental contact with exposed wiring. However, there is a hazard associated with housing and enclosures. A malfunction within the equipment—such as deteriorated insulation—may create an electrical shock hazard. Many metal enclosures are connected to a ground to eliminate the hazard. If a "hot" wire contacts a grounded enclosures, a ground fault results which normally will trip a circuit breaker or blow a fuse. Metal enclosures and containers are usually grounded by connecting them with a wire going to ground. This wire is called an equipment grounding conductor. Most portable electric tools and appliances are grounded by this means. There is one disadvantage to grounding: a break in the grounding system may occur without the user's knowledge.

Insulation may be damaged by hard usage on the job or simply by aging. If this damage causes the conductors to become exposed, the hazards of shocks, burns, and fire will exist. Double insulation may be used as additional protection on the live parts of a tool, but double insulation does not provide protection against defective cords and plugs or against heavy moisture conditions.

The use of a ground-fault circuit interrupter (GFCI) is one method used to overcome grounding and insulation deficiencies.

What is a GFCI?

The GFCI is a fast-acting circuit breaker which senses small imbalances in the circuit caused by current leakage to ground and, in a fraction of a second, shuts off the electricity. The GFCI continually matches the amount of current going to an electrical device against the amount of current returning from the device along the electrical path.

Whenever the amount “going” differs from the amount “returning” by approximately 4 milliamps, the GFCI interrupts the electric power within as little as 1/40 of a second.

However, the GFCI will not protect the employee from line-to-line contact hazards (such as a person holding two “hot” wires or a hot and a neutral wire in each hand). It does provide protection against the most common form of electrical shock hazard—the ground fault. It also provides protection against fires, overheating, and destruction of insulation on wiring.

What Are the Hazards?

With the wide use of portable tools on construction sites, the use of flexible cords often becomes necessary. Hazards are created when cords, cord connectors, receptacles, and cord- and plug-connected equipment are improperly used and maintained.

Generally, flexible cords are more vulnerable to damage than is fixed wiring. Flexible cords must be connected to devices and to fittings so as to prevent tension at joints and terminal screws. Because a cord is exposed, flexible, and unsecured, joints and terminals become more vulnerable. Flexible cord conductors are finely stranded for flexibility, but the strands of one conductor may loosen from under terminal screws and touch another conductor, especially if the cord is subjected to stress or strain.

A flexible cord may be damaged by activities on the job, by door or window edges, by staples or fastenings, by abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire. A frequent hazard on a construction site is a cord assembly with improperly connected terminals.

When a cord connector is wet, hazardous leakage can occur to the equipment grounding conductor and to humans who pick up that connector if they also provide a path to ground. Such leakage is not limited to the face of the connector but also develops at any wetted portion of it.

When the leakage current of tools is below 1 ampere, and the grounding conductor has a low resistance, no shock should be perceived. However, should the resistance of the equipment grounding conductor increase, the current through the body also will increase.

Thus, if the resistance of the equipment grounding conductor is significantly greater than 1 ohm, tools with even small leakages become hazardous.

Preventing and Eliminating Hazards

GFCIs can be used successfully to reduce electrical hazards on construction sites. Tripping of GFCIs—interruption of current flow—is sometimes caused by wet connectors and tools. It is good practice to limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors. Providing more GFCIs or shorter circuits can prevent tripping caused by the cumulative leakage from several tools or by leakages from extremely long circuits.

Employer's Responsibility—OSHA ground-fault protection rules and regulations have been determined necessary and appropriate for employee safety and health. Therefore, it is the employer's responsibility to provide either: (a) ground-fault circuit interrupters on construction sites for receptacle outlets in use and not part of the permanent wiring of the building or structure; or (b) a scheduled and recorded assured equipment grounding conductor program on construction sites, covering all cord sets, receptacles which are not part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees.

Ground-Fault Circuit Interrupters—The employer is required to provide approved ground-fault circuit interrupters for all 120-volt, single phase, 15 and 20 ampere receptacle outlets on construction sites which are not a part of the permanent wiring of the building or structure and which are in use by employees. Receptacles on the ends of extension cords are not part of the permanent wiring and, therefore, must be protected by GFCIs whether or not the extension cord is plugged into permanent wiring. These GFCIs monitor the current-to-the-load for leakage to ground. When this leakage exceeds 5 mA ± 1 mA, the GFCI interrupts the current. They are rated to trip quickly enough to prevent electrocution. This protection is required in addition to, not as a substitute for, the grounding requirements of OSHA safety and health rules and regulations, 29 CFR 1926. The requirements which the employer must meet, if he or she chooses the GFCI option, are stated in 29 CFR 1926. 404(b)(1)(ii).

Assured Equipment Grounding Conductor Program—The assured equipment grounding conductor program covers all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. The requirements which the program must meet are stated in 29 CFR 1926.404(b)(1)(iii), but employers may provide additional tests or procedures. OSHA requires that a written description of the employer's assured equipment grounding conductor program, including the specific procedures adopted. be kept at the jobsite. This program should outline the employer's specific procedures for the required equipment inspections, tests, and test schedule.

The required tests must be recorded, and the record maintained until replaced by a more current record. The written program description and the recorded tests must be made available, at the jobsite, to OSHA and to any affected employee upon request. The employer is required to designate one or more competent persons to implement the program.

Electrical equipment noted in the assured equipment grounding conductor program must be visually inspected for damage or defects before each day's use. Any damaged or defective equipment must not be used by the employee until repaired.

Two tests are required by OSHA. One is a continuity test to ensure that the equipment grounding conductor is electrically continuous. It must be performed on all cord sets, receptacles which are not part of the permanent wiring of the building or structure, and on cord- and plug-connected equipment which are required to be grounded. This test may be performed using a simple continuity tester, such as a lamp and battery, a bell and battery, an ohmmeter, or a receptacle tester.

The other test must be performed on receptacles and plugs to ensure that the equipment grounding conductor is connected to its proper terminal. This test can be performed with the same equipment used in the first test.

These tests are required before first use, after any repairs, after damage is suspected to have occurred, and at 3-month intervals. Cord sets and receptacles which are essentially fixed and not exposed to damage must be tested at 6-month intervals. Any equipment which fails to pass the required tests shall not be made available for or used by employees.

SUMMARY

Following these rules and regulations will help reduce the number of injuries and accidents from electrical hazards. Work disruptions should be minor, and the necessary inspections and maintenance should require little time.

SOURCE: OSHA, 1987. Booklet No. 3007

Section 6

6.0 CONSTRUCTION QUALITY ASSURANCE PLAN

6.1 PURPOSE

This Construction Quality Assurance Plan (CQAP) has been prepared as part of the Remedial Action (RA) for the PGCS facility at the ACS Site. The purpose of this CQAP is to outline the personnel and methods involved in verifying compliance with the Remedial Design, and contractual and regulatory requirements.

6.2 SCOPE

Included in this CQAP are the following elements:

- Description of parties involved in completion of the RA, as well as discussions of their responsibility, authority, and qualifications.
- Description of construction quality assurance procedures used to evaluate the RA.
- Description of documentation and record keeping activities.

6.3 RESPONSIBILITY AND AUTHORITY

The organizational structure for the RA activities at the ACS Site has been designed to facilitate communication and reporting during the execution of construction activities at the site. The key personnel tasked with quality control and oversight of construction activities for the PGCS system are listed below.

Title	Name
Principal-In-Charge	Mr. Joe Adams
Program Manager	Mr. Pete Vagt
Engineering Manager	Mr. Ron Schlicher
Construction Manager	Mr. Todd Lewis
Construction Superintendent	Mr. Ben McGeachy
On-Site Safety Officer	Mr. Lee Orose
Construction Quality Assurance Inspector	Mr. Lee Orose
Construction Quality Assurance Manager	Mr. Jack Dowden (Resume Attached)

The primary responsibilities of the above listed individuals are summarized below.

6.3.1. Principal-In-Charge

The Principal-In-Charge will act as the primary liaison between ACS, U.S. EPA, IDEM, and Montgomery Watson and its subcontractors. The Principal-In-Charge will be directly responsible for the contractual commitments, assuring that the necessary resources are dedicated to the project, and for the overall project quality. The Principal-In-Charge will review all pertinent documents and submittals which are part of the RD/RA work at the ACS Site, and approve all change orders or modifications to the project scope of work. The Principal-In-Charge will also certify that information contained in submissions is true accurate and complete.

6.3.2. Program Manager

The Program Manager will be responsible for generating and updating the cost, schedule, and performance reports, and providing input to me Principal-in-Charge on an as-needed basis. The Program Manager will assist the Principal-in-Charge by ensuring that the necessary resources are committed to the project. The Project Manager will also be responsible for approving the project-specific documents, task deliverables, and work plans, authorizing assignment to the project team members, and establishing and enforcing work element milestones for timely completion of RA work.

6.3.3. Engineering Manager

The Engineering Manager will be responsible for the successful execution and administration of all engineering-related activities. Primary engineering responsibilities include development of adequate construction documents, securing the required permits, shop drawing review, as-built drawing development, and overall conformance to the applicable regulations and work controlling documents. The Engineering Manager will be the main liaison between the field teams and engineering support teams during the construction phase.

6.3.4. Construction Manager

The Site Manager is responsible for (1) successful execution and administration of all construction activities related to the ACS Site, (2) ensuring that all construction activities proceed in accordance with the approved construction documents, (3) ensuring that all field activities are conducted in compliance with the applicable regulatory and health and safety requirements, (4) collecting all pertinent information specified in the construction documents for submittal to the Engineering Manager, (5) resolving site problems and informing the Engineering Manager of the same, (6) approve/disapprove all material and labor costs for field work, (7) negotiate construction change orders, and (8) review all field data.

6.3.5. Construction Superintendent

The Construction Superintendent is responsible for the overall direction of the field team. The Construction Superintendent is also responsible for ensuring contractual compliance through implementation of the practices and procedures described in the contract documents, for supervision/field inspection functions, and for facilitation and integration of field activities. The Construction Superintendent will report directly to the Construction Manager.

6.3.6. On-Site Safety Officer

The On-Site Safety Officer is responsible for ensuring that the construction activities are in compliance with the approved Health and Safety Plan. The On-Site Safety Officer will hold tailgate meetings and keep the field team members informed of the site hazards. The On-Site Safety Officer will report to the Construction Manager.

6.3.7. Construction Quality Assurance (CQA) Inspector

The CQA Inspector is responsible for observing and documenting activities related to the completion of the RA. The CQA Inspector will observe and document work completed at the site and verify that installation requirements are met. The CQA Inspector is responsible for assuring that quality assurance testing is completed in accordance with the specifications, and that elements of the RA meet the specifications.

The CQA Inspector will maintain daily reports of construction activities at the site. Included in these reports will be a summary of the days activities, a discussion of problems encountered and their solutions, and a discussion on deviations from the approved design. Reports will also include a description of quality assurance testing activities and results. The CQA Inspector will be responsible for the oversight of any laboratory testing completed to fulfill requirements of the specifications.

6.3.8. Construction Quality Assurance (CQA) Manager

The CQA Manager is responsible for assuring that all construction activities are performed in accordance with the Construction Quality Assurance Plan (CQAP). The CQA Manager will oversee the activities of the CQA Inspector and will resolve all construction quality problems that may arise. The CQA Manager will maintain daily reports of construction activities in his files. The CQA Manager will work independently of the Construction Manager and will report construction quality problems directly to the Engineering Manager.

6.3.9. Other Montgomery Watson and Subcontractor Staff

All Montgomery Watson and subcontractor staff are responsible for complying with the construction documents, work plans, procedures, and instructions. The type of subcontractors to be used at the site include the following:

- Earthwork Subcontractor;
- Metal Building Fabricator;
- General Plumbers, Electricians, Utility Workers, Pipe Fitters;
- Concrete Work Subcontractors;
- Equipment Vendors;
- Geotechnical Testing Subcontractor;
- Certified Analytical Laboratory;
- Trenching Subcontractor;
- Well Driller, if required; and,
- Hazardous Waste Transporters and Disposal Facility.

The Construction Superintendent, with assistance from the Construction Manager, will provide coordination of the subcontractor activities, including contract bidding and execution, scheduling, site access, equipment and material movement, and documentation.

6.4 PRECONSTRUCTION PHASE QUALITY ASSURANCE

6.4.1. Purpose and Scope

This section presents the specific preconstruction-phase quality assurance requirements for the construction activities at the ACS Site.

6.4.2. Meeting Requirements

A preconstruction meeting will be held at the site prior to beginning of the RA work. The preconstruction meeting will be attended by a representative of the ACS Technical Committee, the Construction Manager, the Construction Superintendent, the CQA Inspector, representatives of the U.S. EPA and IDEM, and selected subcontractors. This CQAP will be reviewed along with other pertinent site documents to ensure that the responsibility of each party is well defined and understood. The Preconstruction Meeting Agenda will be prepared by Montgomery Watson and distributed to all involved parties in advance of the meeting. The meeting will be documented by the Site Manager, and minutes will be transmitted to all participants.

6.4.3. Preconstruction Checklist Items

Each of the following items must be completed prior to commencing field work:

- Montgomery Watson will provide any required permits or approvals for the PGCS system construction and operation;
- Review of the Health and Safety Plan and worker training status;
- Identification of all project team members and listing of 24-hour telephone numbers;
- Identification of site access/restrictions;
- Verification of availability and location of utilities;
- Finalization and approval of the project schedule;

- Ensure that subcontractors (such as the analytical laboratory and excavation subcontractor) are ready, subcontracts are signed, and insurance provided.

Additional information on several of the checklist items is presented below.

6.4.3.1. Permits. Under the CERCLA authorization, no federal or state permits are required for any on-site activities involved as part of the construction/operation of the PGCS facility. However, permits and/or approvals may be required for off-site activities and from the local utility agencies. A more detailed discussion of this topic is provided in Section 3.0 of this document. Montgomery Watson would coordinate the permits or approvals with local agencies in advance of the RA work.

6.4.3.2. Site Access and Restrictions. The construction activities will be coordinated in advance with the appropriate point of contact for the ACS facility (Mr. Tom Froman). Montgomery Watson will provide notification for all work planned at the site and identify issues affecting the performance of work at the ACS facility.

6.4.3.3. Availability of Utilities. Potable water, sewer, gas and electric service will be provided by ACS and the local utility companies; however, Montgomery Watson will arrange for utility connections. Locations of underground utilities which may affect the excavation will be checked.

6.4.4. Submittals

The submittals during the preconstruction-phase will include:

- Health and Safety Plan addendum
- Applicable permits and/or approvals from local agencies

6.5 CONSTRUCTION-PHASE QUALITY ASSURANCE

6.5.1. Purpose and Scope

This section presents the specific construction phase quality assurance activities for the ACS Site.

6.5.2. Meeting Requirements

Construction Progress Meetings will be held on a weekly basis and chaired by Construction Superintendent. The primary subcontractors must send an authorized representative to each meeting.

The RPM meetings will be held as required and chaired by the U.S. EPA or their designated representative. Montgomery Watson will attend all RPM meetings during the course of this contract. Subcontractors will not be required to attend these meetings, unless requested by ACS or Montgomery Watson. The intent of the meetings will be to provide the RPM with a progress update and to work through any regulatory related issues that might hold up the progress of the work.

6.5.3. Inspection and Observation

6.5.3.1. Construction Progress and Conformance Inspections. For the PGCS facility work, construction-phase inspections include receiving inspections and in-progress inspections.

Receiving Inspections

Receiving inspections for equipment and materials will be performed by the Construction Manager or his designated representative. The following receiving inspections are required for the PGCS facility:

- Mechanical equipment including the treatment system components and piping will be checked and documented by the Construction Superintendent;
- Metal building components will be checked and documented by the Construction Superintendent;
- Chemicals for the treatment system operation will be checked and documented by the Construction Superintendent;
- Well construction material will be verified by a hydrogeologist;

- Inspection and laboratory sampling and testing of import backfill materials for foreign or objectionable materials will be performed by the Construction Superintendent and verified by the Construction Manager.

In-Progress Inspections

Regular in-progress inspections will be conduced to verify compliance with the contract documents. Inspections will be performed by the Construction Superintendent and include the following:

- Overseeing the trenching subcontractor to confirm that the trench is being constructed in accordance with the drawings and specifications and that actual construction is being correctly documented;
- Ensuring that the subcontractor is taking appropriate measures to control and minimize dust emissions and erosion at the site related to the subcontractor's work activities;

- Ensuring that trucks and equipment are properly decontaminated, and decontamination water and residuals are properly managed and disposed;

- Ensuring that security measures are being followed including entry by authorized persons only, use of appropriate personnel protection equipment, protection of ACS-owned property, and locks and other measures to prevent unauthorized entry when the work site is unmanned;

- Ensuring the use of effective barricade and other temporary controls to prevent stormwater runoff and construction-related runoff. Also ensuring that the runoff is collected and appropriately treated;

- Conduct compaction and relative density testing of compacted backfill to ensure that the specified percent compaction is achieved.

6.5.3.2. Health and Safety Compliance Inspections. For the ACS Site work, periodic health and safety inspections will be conducted by the Construction Superintendent in accordance with the Health and Safety Plan.

6.5.3.3. Startup. The PGCS facility will require a formal start up and prove-out in accordance with the procedures described in Section 7.0 Operation and Maintenance

(O&M) Plan. The O&M Plan will be finalized during the construction phase after actual equipment has been purchased and installed.

6.5.4. Reporting and Documentation

6.5.4.1. Daily Construction Reports. Daily construction reports summarizing inspection results will be submitted during the course of the construction. The CQA Manager will produce the daily construction reports and submit them to the Site and Engineering Managers. In turn, the Construction Manager will submit the reports to the U.S. EPA personnel. The daily reports will address the following issues:

- Weather conditions;
- Name of each subcontractor on the job that day, including number of manual workers by craft and names of non-manual workers (supervisors) at the site;
- List name, employer, and time in and out of any visitors to the site;
- List identity, size and type of all major pieces of equipment at the site each day. Indicate if idle, and reason, if applicable;
- Log status of all work started and in progress, including the entity performing the work;
- Record type and quantity of materials delivered to the job;
- List any samples collected and tests performed;
- Record movement of major construction equipment to and from the job site;
- Reference any quality deficiencies or unsafe conditions, and actions taken to correct the same;
- List all tests performed at the site. Results should be reported by the lab making the test. Note the location of the test and the report number;
- Signature of person preparing the report, including full name, title and date;

Any photographs of the construction activities will be cross referenced with observation and testing information. The photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints. Negatives will be stored in a separate file.

6.5.4.2. Field Testing Reports. Records of field and laboratory testing performed at the site must be managed by the CQA Inspector. A summary list of test results will be prepared by the CQA Inspector on an ongoing basis, and submitted to the Construction Manager.

6.5.4.3. Progress Reports. The ACS Steering Committee will submit to the U.S. EPA signed monthly reports during the construction phase. These progress reports will include as a minimum (and as appropriate):

- A description and estimate of the percentage of the RA work completed;
- Summary of findings:
- Summary of changes made in the RA from the original plan during the reporting period;
- Summaries of contacts with representatives of the local community, public interest groups, or State government during the reporting period;
- Summary of problems or potential problems encountered during the reporting period, and actions being taken to address these problems;
- Changes in key personnel during the reporting period;
- Projected work activities for the next reporting period;
- Copies of daily reports, inspection reports, and laboratory/monitoring data;
- Comparison of working schedule to project schedule;
- Summaries of conference calls and meeting held during the reporting period between the ACS and the U.S. EPA.

- Copies of contractor progress reports prepared by Montgomery Watson.

6.5.4.4. Inspection Reports. Inspection Reports will be completed after each of the required inspections have occurred to document the inspections. Documentation of the inspections will be prepared by the Construction Manager and will be issued to all participants in the inspection meeting.

6.5.4.5. Record Drawings. The Construction Manager or designated representative will maintain a set of marked-up drawings which will be updated on a continuous basis. The record drawings will include as a minimum:

- Actual pipeline routes and utility tie-ins;
- Measured grade of finished surface of each component;
- Any significant changes from the 100 Percent Design Drawings.

A copy of the final record drawing will be submitted to the ACS Steering Committee at the completion of the project.

6.5.5. Sampling and Testing

6.5.5.1. Sampling and Testing Plan. There is no environmental sampling and testing to be conducted as part of the PGCS construction. There will, however, be sampling and testing of materials (such as backfill, road base, concrete, etc.) that are brought in to construct the facility. Examples of testing include the following:

- Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

- Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

- Compaction test requirements on fill, backfill, and embankment materials will be performed in accordance with ASTM D 1557.

- Moisture-Density relationships of soils and soil-aggregate mixtures will be performed using a 10-lb Rammer and 18-inch drop for type A, B, G, H, I, and

M materials. Test methods for type B, E, and F materials will be in accordance with ASTM D 4253 and ASTM D 4254.

- When soil material is required to b compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 1556 - Test Method for Density of Soil in Place by the Sand Cone Method, ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), or by other acceptable means.

- Percentage loss of gravel base materials will be determined in accordance with ASTM C131.

- Sand equivalent of gravel base materials will be determined in accordance with ASTM D 2419.

- Gradation of gravel base materials will be determined in accordance with ASTM c 117 and ASTM C 136.

- Moisture-density of curves of gravel base materials will be prepared in accordance with ASTM D 1557.

- Compaction of gravel base materials will be in accordance with ASTM D 1557.

- All gravity sewer pipes and service laterals will be tested for exfiltration or infiltration and deflection. All manholes will be tested for leakage. Manholes will be tested prior to backfill placement, whereas all pipe will be backfilled prior to testing.

- All water pipelines will be disinfected and hydrostatically tested for leaks prior to being put into service. After final flushing samples will be collected and tested for bacteriological quality in accordance with the requirements of the State Department of Health or other appropriate regulatory agency.

- All other piping will be pressure tested per the applicable piping code.

- All major mechanical, electrical and instrumentation equipment, systems, and subsystems will be tested for functionality prior to treatment system start-up.

Specific tests on each component, or material used in the construction of this project will be included in the contracting documents with each subcontractor.

6.6 POST-CONSTRUCTION PHASE QUALITY ASSURANCE

6.6.1. Purpose and Scope

Post-construction phase quality assurance requirements for the ACS Site are detailed in this subsection. This phase of quality assurance will be conducted by the CQA Inspector.

6.6.2. Inspections

6.6.2.1. Prefinal Inspection. As the project is nearing completion, a prefinal inspection meeting will be held at the site. The prefinal inspection will be attended by a representative of the ACS Technical Committee, the Construction Manager, the Construction Superintendent, and a representative from the U.S. EPA. The prefinal inspection will consist of a walk-through inspection of the entire project area and all facilities. The prefinal inspection will determine whether the project is being completed consistent with the contract documents. Any outstanding construction items noted during the prefinal inspection will be recorded. A prefinal inspection report will outline the outstanding construction items, actions required to resolve items, completion dates for these items, and the date for the final inspection.

6.6.2.2. Final Inspection. Upon completion of any outstanding construction items, a final inspection meeting will be held at the site. The final inspection will be attended by a representative of the ACS Technical Committee, Construction Manager, Construction Superintendent, and a representative from the U.S. EPA. The final inspection will consist of a walk-through inspection of the entire project area and all facilities. The prefinal inspection report will be used as a checklist and will focus on the outstanding construction items.

6.6.3. Construction Completion Report

Following the final inspection, a Construction Completion Report will be prepared by the CQA Manager and a registered professional engineer and will be submitted to the ACS Steering Committee for submittal to the U.S. EPA. The Construction Completion Report will confirm that the work has been performed in substantial compliance with the design plans and specifications. The Construction Completion Report will include the following:

- Summary of construction activities;
- Data quality control reports for field activities, including sampling and analytical results and other field inspections;
- Marked-up drawings indicating any deviations in the construction work from the original design drawings;
- Photographic documentation.

6.6.4. Final Storage of Records

Final storage of the completion of the RA will be maintained in the Site Manager's files. Copies of reports and other submittals will be retained by the ACS Steering Committee and the U.S. EPA.

JACK DOWDEN
PROJECT MANAGER

EDUCATION:

M.S., 1981, University of Nevada, Reno, Hydrogeology
B.S., 1978, University of Wisconsin, River Falls, Earth Science

SUMMARY:

As a practicing hydrogeologist with over fourteen (14) years of experience, Mr. Dowden has been responsible, both as a consultant and as an industry representative for performing and managing a wide range of site investigation, environmental permitting and remediation projects. His range of experience includes existing and proposed landfills, nuclear testing sites, mines, manufacturing facilities, coal-tar plants and Superfund sites. Mr. Dowden specializes in project management, the analysis of urban hydrogeologic settings, major project permitting, negotiating with regulatory agencies and the application of in-situ remedial techniques.

In his role as Project Manager and Senior Hydrogeologist, Mr. Dowden is responsible for directing multi-disciplinary environmental projects for public and private sector solid waste management clients and providing oversight, direction and QA/peer review for site investigation and remediation projects.

EXPERIENCE:

Project Manager, State and Federal Superfund Remediations

- Managed the regional environmental program for a major solid waste management company. Responsibilities as program manager included landfill remediation, environmental monitoring, special waste management and internal compliance for 22 active and closed landfills and 34 waste hauling operations. The primary element of this program was management of seven state and federal Superfund remediations.

Project Manager, Landfill Design and Permitting Services

- Directed a multi-disciplinary team selected by a major solid waste management company to provide landfill design and permitting services for five existing and two proposed solid waste landfills in Illinois, Indiana and Missouri. This role included oversight and management of activities ranging from local siting, permit preparation and negotiation, and construction quality assurance. Worked closely with the client's director of facility development to control overall project cost, project closure and post-closure care costs, and communicate with state and local regulatory officials.

Project Manager, Ash Disposal Site Selection/Development Plan

- Managed the site selection process for coal-fired power plant ash disposal site in southeast Wisconsin, and subsequent preparation of a site development plan. The site selection process utilized a multi-attribute site ranking system to screen and evaluate over 90 potential sites in a four county area. Worked closely with corporate staff, regional planners, state and county officials and potentially affected public. The final site development included disposal cells, environmental corridors and buffer zones, a prairie restoration area, a shoreline stabilization zone, and a multi-use recreational end-use.

Project Manager, U.S. AFB Site Investigations

- Managed initial site investigations of on-base landfills, fire training facilities and fuel distribution systems at three active U.S. Air Force bases in the Upper Midwest. These investigations lead to the identification and eventual remediation of 16 separate impacted areas, including three state and/or National Priority List sites.

Groundwater Evaluation/Recovery System Installation

- Performed a groundwater evaluation at a magnetic tape manufacturing facility and subsequently managed the design and installation of a groundwater recovery system. This was the first groundwater pump and treat system in the State of Colorado to receive closure certification.

Lead Hydrogeologist, Superfund Site RI/FS Work Plan

- Served as lead hydrogeologist for the initial site investigation and RI/FS work plan preparation for the 52nd and McDowell Road Superfund site in Phoenix, Arizona. The initial assessment activities included installation of multi-level monitor wells, performance of aquifer pump tests and soil-gas surveying. These efforts lead to identification of the migration pathway and streamlining of the subsequent RI scope of work.

Expert Reviews, UST Projects

- Provided third-party Expert Review on a number of UST projects located in urban settings. This review was performed in response to the client's concerns over data inconsistencies and the apparent generic nature of the proposed remedial actions. This review and the subsequent investigations results demonstrated that migration along substructures (footings and buried utilities) were the primary migration pathways and that the previously recommended actions would not have adequately addressed these pathways.

Hydrogeologic/Geochemical Characterization

- Participated in a hydrogeologic and geochemical characterization of Micronesian island atolls which were previously used for nuclear weapons testing. The results of this project provided the basis for explaining the recirculation of radioactive strontium in the localized hydrologic cycle.

CERTIFICATIONS:

U.S. EPA Health and Safety Training
Communicating with Media
Effective Supervision
Total Quality Management

Section 7

SECTION 7.0

OPERATION AND MAINTENANCE PLAN/CONTINGENCY PLAN

The following is a draft of the Operation and Maintenance Plan/Contingency Plan for the PGCS.

DRAFT

OPERATION AND MAINTENANCE PLAN/CONTINGENCY PLAN

AMERICAN CHEMICAL SERVICE, INC. NPL SITE

GRIFFITH, INDIANA

FEBRUARY 1996

PREPARED FOR:

ACS RD/RA EXECUTIVE COMMITTEE

PREPARED BY:

MONTGOMERY WATSON AMERICAS, INC.

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1. Site Description

The American Chemical Service, Inc. (ACS) Site is located at 420 South Colfax Avenue in the City of Griffith, Indiana, which is in the northwestern corner of the state. The site is bordered on the east and northeast by Colfax Avenue. The Chesapeake and Ohio railway bisects the site in a northwest-southeast direction, between the fenced On-Site Area (north) and the Off-Site Area (south). On the west and northwest, south of the Chesapeake and Ohio railway, the site is bordered by the abandoned Erie and Lackawanna railway, and the active portion of the Griffith Municipal Landfill. North of the Chesapeake and Ohio railway, the site is bordered on the west by wetland areas. The northern boundary of the site is formed by the Grand Trunk railway.

There are five land disposal areas at the ACS Site: the On-Site Containment Area (ONCA), the Still Bottoms Pond (SBP) Area, the Treatment Lagoons, the Off-Site Containment Area (OFCA), and the Kapica/Pazmey Area[1]. Although the Griffith Municipal Landfill is located within the boundaries of the site, it is not included as part of the remedy. The landfill is an active solid waste disposal facility that has operated since the 1950s and it is currently going through closure.

1.1.2. Operational History

Based on information provided by American Chemical Service, Inc., the ACS facility began operation in May 1955 as a solvent recovery facility. Solvent recovery remained the primary operation performed on-site through in the late 1960s, when the manufacture of small quantities of specialty chemicals began. These manufacturing operations included treating rope with fungicide, bromination and treating ski cable.

[1] The terms On-Site and Off-Site are used to denote particular portions of the ACS Site: both areas are within the CERCLA Site. The Off-Site Containment area is designated as off-site only because it is adjacent to, rather than within the boundaries of the property where ACS currently conducts its chemical formulation operations. However, ACS owns the property and as noted, for CERCLA purposes, both of these areas are considered on-site.

In 1961, ACS sold a two-acre parcel to John Kapica, and in 1962 Kapica began the operation of his drum reclaiming business at the location. Operations at Kapica Drum, Inc., consisted of drum reconditioning. Kapica Drum was sold to Pazmey Corporation in February 1980. Kapica/Pazmey operated from 1980 to 1987. The Pazmey Corporation property was sold to Darija Djurovic in March 1987.

ACS' solvent operations involved spent solvent mixtures containing alcohols, ketones, esters, chlorinated solvents, aromatics, aliphatics, and glycols. In the early years of operation, spent solvents were stored in 55-gallon drums at various locations at the Site. Solvent recovery was performed in batch evaporation units, which were charged by pumping material directly from 55-gallon drums into the evaporation vessels. Still bottoms from the evaporation vessels were disposed in the Still Bottom Pond, prior to the installation of incinerators at the facility. ACS installed its first incinerator in 1966 and installed a second incinerator in 1969. The incinerators were used to burn still bottoms and non-reclaimable materials generated at the site, and wastes from off-site. The incinerator units were dismantled in 1977.

From 1970 to 1975, the spent solvents reclaimed at the site were similar to those which were handled in the 1960s. However, an increasing percentage of shipments were received at the site in bulk tanker trucks. In addition, the batch manufacturing processes were expanded during this period. A lard oil process which utilized tallow and animal rendering was used to manufacture a lubricant product. This process, along with a soldering flux operation, was discontinued prior to 1990. In 1971, the additive manufacturing area was built. Various detergents lubricants, and chemical additives were manufactured, in addition to soldering flux, various amines, methanol, formaldehyde, sodium hydroxide, and maleic anhydride. An epoxidation plant was constructed in 1974 and a bromination operation using hexane was added in 1975. At various times up until 1990, the epoxidation plant used toluene or benzene as a reaction carrier.

Some time between 1975 and 1990, the solvent distillation units were replaced with new units though the types of solvent wastes reclaimed remained essentially the same. Spent solvent and reclaimed solvent recovery tank farms were constructed during this time period and the majority of the spent solvent waste streams were shipped in bulk tanker trucks, although drummed wastes were still processed. A hazardous waste drum unloading dock and storage area were built in the early 1970s, with spill containment curbing and a sump area added at a later date. In September 1990, ACS ceased accepting hazardous waste shipments and filed for closure. On March 31, 1993 ACS completed closure and terminated its interim RCRA status. ACS currently operates as a chemical production facility at the site.

1.1.3. Land Disposal History

When ACS began operations in 1955, the still bottoms from the solvent recovery operations were disposed of in the Still Bottoms Pond/Treatment Lagoon area. In 1972, the pond and lagoons were drained, and drums, partially filled with sludge materials, were landfilled there.

The OFCA was utilized for the landfilling of wastes including excavated materials from the Still Bottoms/Treatment Lagoon from 1958 to 1975. The waste types disposed of in the OFCA over the course of ACS' operations also included general refuse, drums, still bottoms and incinerator ash. According to the ACS, Inc. owner/operators, drums placed in the OFCA were crushed or punctured as part of the disposal process.

During the mid-1960s, it is estimated that approximately 400 drums of sludge and semi-solids were landfilled in the ONCA. Observations made during test pit excavations in 1993 did not detect any intact drums. Residual wastes and rinse waters from the Kapica/Pazmey drum reconditioning operation were disposed of on the ground in the Kapica/Pazmey Area.

1.1.4. Administrative History

In February 1980, the U.S. EPA performed a Preliminary Assessment of the ACS Site, collecting samples in the Off-Site Containment Area and at the Griffith Municipal Landfill in May 1980. The U.S. EPA performed a site inspection on September 9, 1980, and in July 1982. U.S. EPA contractors installed four monitoring wells near the Off-Site Containment Area and the Griffith Landfill. Based upon information developed during these investigative efforts, a hazard ranking system score of 34.98 was assigned to the ACS Site by U.S. EPA in June 1983.

In 1986, a group of approximately 125 Potentially Responsible Parties (PRPs) formed a Steering Committee to conduct the Remedial Investigation/Feasibility Study (RI/FS) pursuant to an agreement with the U.S. EPA. The PRPs signed a Consent Order to perform the RI/FS in June 1988. Following U.S. EPA approval of the RI/FS Work Plan, the field investigation for Phase I of the RI began in July 1989. Phase II RI field work began in March 1990, and in December 1990, the Phase III RI field work was initiated. The RI report was completed in June 1991. Warzyn (now Montgomery Watson Americas, Inc.) completed the FS report in June 1992.

In June 1992, the U.S. EPA published notice of its Proposed Plan for Remedial Action for the ACS Site. The remedy presented in that Proposed Plan was described by U.S. EPA as a modification of Remedial FS Alternative 6B. The U.S. EPA issued a Record of Decision (ROD) in September 1992. The UAO was issued on September 30, 1994. The Respondents provided notice to the U.S. EPA of their intent to comply with the UAO, and have developed the planning documents and performed other tasks required by the UAO to date.

1.2 SCOPE OF THE PERIMETER GROUNDWATER CONTAINMENT SYSTEM

The remedy presented in the ROD for the ACS Site includes the following components:

- Groundwater pumping and treatment to dewater the site and to contain the contaminant plume with subsequent discharge of the treated groundwater to surface water and wetlands;
- Excavation of approximately 400 buried drums in the ONCA for off-site incineration;
- Excavation of buried waste materials and treatment by low temperature thermal treatment (LTTT);
- On-site treatment or off-site disposal of treatment condensate;
- Vapor emission control during excavation and possible immobilization of inorganic contaminants after LTTT;
- Off-site disposal of miscellaneous debris;
- In-situ vapor extraction pilot study of buried waste in the On-site Area;

- In-situ vapor extraction of contaminated soils;

- Continued evaluation and monitoring of wetlands and, if necessary, remediation;

- Long-term groundwater monitoring;

- Fencing the Site and implementation of deed and access restrictions and deed notices; and

- Private well sampling with possible well closures or groundwater use advisories.

During meetings held early in 1995 with the Respondents, U.S. EPA, and IDEM, the agencies expressed a desire to have some components of the remedy designed and constructed on an expedited basis. The Respondents expressed a similar desire and voluntarily agreed to expedite the design and construction of a groundwater collection and treatment system. The objective of the system is to prevent off-site migration of contaminants in the upper aquifer along the downgradient perimeter of the site. The system is not intended to remediate the full extent of groundwater contamination, but it will be an integral component of the overall remedy. Additional groundwater remediation activities will be addressed after the extent of contamination has been better defined.

Since the PGCS is the first component of the overall remedy, it is being designed with a high degree of flexibility such that it can easily be integrated with future components of the remedy. For example, the strategy for the site includes the installation of dewatering systems to control migration of contamination from the waste areas and to allow for pilot tests to be conducted in unsaturated material. Water extracted from the dewatering systems will need to be treated. Consequently, the treatment system for the PGCS is being designed to handle waste area flows and to allow for easy expansion if necessary.

1.3 GROUNDWATER CHARACTERIZATION

1.3.1. Sources of Groundwater

Although the initial purpose of the treatment system will be to treat groundwater extracted from the trench, it will also need to handle waters generated from other remedial actions at the site. The other activities that will generate contaminated water include:

- Lowering the water table in the On-Site Containment Area (ONCA) as part of a soil vapor extraction (SVE) pilot study and during implementation of the full-scale SVE system;

- Lowering the water table in the Still Bottoms Pond/Treatment Lagoon Area (SBP) after the subsurface barrier wall is installed. (The barrier walls will be installed to: (1) prevent further migration of contaminated groundwater from the waste areas; (2) allow dewatering of the areas while minimizing the volume of water to be treated and thus the overall flow to the treatment system.);

- Dewatering of a small area within the SBP during a SVE pilot study;

- Lowering the water table in the Off-Site Containment Area (OFCA) after the barrier wall is installed; and

- Dewatering of a small area within the OFCA during the excavation, material handling, and low temperature thermal treatment pilot study.

A description of the anticipated flow and the nature of contaminants associated with liquids from each source area is presented in the following sections.

1.3.2. Flow and Scheduling of Groundwater

The hydraulic capacity of the treatment system will be based on the contributions of flow anticipated from the four source streams (the PGCS, ONCA, OFCA, and SBP). The flows for the PGCS and ONCA were estimated using the recent pump test data, basic assumptions about the aquifer properties, and the MODFLOW groundwater model.

Since subsurface barrier walls will be installed around the OFCA and SBP, flows from these areas were estimated by calculating the volume of water to be removed and dividing by the desired dewatering period. The volume of water to be removed was assumed to be equal to the volume of the saturated zone (above the silty clay) within the area to be dewatered multiplied by an assumed porosity (0.3 for the OFCA and 0.4 for the SBP). As the water table is drawn down to the desired level, the flow will decrease. Once the water table has been lowered, the flow will be equal to the amount of infiltration into the area. Data suggest that some upward flow may exist in this area through the silty clay, but for the purposes of the dewatering calculations it has not been included. For the design, it was assumed that the dewatering of the two areas would be accomplished concurrently over a five year period.

The flow contributions from the small areas within the SBP and OFCA which will be dewatered for pilot testing are unknown at this time. The current plan is to install temporary sheet pile or other type of barrier walls to minimize the volume of water to be extracted. Since these test areas will be located in the most contaminated portions of the site, the extracted groundwater will have high concentrations of contaminants. If possible, the water will be stored in tanks and gradually bled into the treatment system influent. If this approach is not feasible, the water will be properly disposed of at a permitted off-site facility.

Since there are several sources of water, nearly all of which have high flows for a short initial period and then lower flows once steady-state conditions are reached, it is essential to develop a schedule for staggering the activities such that the most appropriate treatment system can designed to meet the project's needs. This approach will avoid the need to design and construct a treatment system to accomodate short duration or limited flows. A schedule for staggering the startup and operation of each of the water-producing activities and the resulting estimated flows to the treatment system is presented in Table 1-1. The schedule is based on the following strategy:

Stage 1: Startup the PGCS (the extraction trench) at an initial flowrate of approximately 40 to 45 gallons per minute (gpm).

TABLE 1-1

ESTIMATED FLOWS AND SCHEDULING TO TREATMENT SYSTEM

Stage	Cumulative Operating Time	Flow PGCS (gpm)	ONCA (gpm)	OFCA (gpm)	SBP (gpm)	Total (gpm)
1	startup	42	0	0	0	42
2	6 months	15	18	0	0	33
3	1 year	12	5	8	5	30
4	2 years	12	30	8	5	55
5	8 to 10 years	12	0	5	3	20

Stage 2: As the extraction trench system reaches steady-state, the flow will decrease. After six months of operation, the flow should be approximately 15 gpm. At this time, the dewatering for the SVE pilot study in the ONCA can begin. Theinitial flow from this system is estimated to be 18 gpm. Total flow to the treatment system from these two sources will be 33 gpm.

Stage 3: After one year of operation, flow from the extraction trench should have reached steady-state which is estimated to be about 12 gpm. Similarly, flow from the ONCA pilot dewatering system should be at a steady-state flow of 5 gpm. It is also anticipated that the subsurface barrier walls for the SBP and OFCA will have been installed by this time and the dewatering wells can be turned on. The dewatering wells will be operated to dewater the areas over a period of five years. The flows are estimated to be 8 gpm from the OFCA and 5 gpm from the SBP. The total combined flow to the treatment system from all sources will be 30 gpm.

Stage 4: After two years of operation, the extraction trench will still be pumping at 12 gpm. By this time, sufficient data will have been collected from the ONCA SVE pilot study to finalize the full-scale design. The first step in implementing the full-scale SVE system will be to increase the extent of the area to be dewatered. The increased flow from this activity is estimated to be 30 gpm. Flows from the OFCA and SBP gradient control wells will still be at 8 gpm and 5 gpm, respectively. Total combined flow to the treatment system will be 55 gpm.

Stage 5: After 8 to 10 years of operation, it is anticipated the extraction trench will still be pumping at 12 gpm and the OFCA and SBP dewatering wells will still be at their estimated maintenance flows of 5 gpm and 3 gpm, respectively. The SVE in the ONCA will have been completed and the dewatering system will be shut down. Total combined flow to the treatment plant will be 20 gpm.

1.3.3. Design Hydraulic Capacity

Based on the estimated flows presented in Table 1-1, the treatment system will be sized for a maximum hydraulic capacity of 60 gpm. A design flow rate of 60 gpm provides more than enough capacity to treat the flows expected during the dewatering of the ONCA for the full-scale SVE (Stage 4). The long term flow to the system will be 20 gpm (Stage 5) based on steady-state pumping from the perimeter extraction trench and maintenance flows from the OFCA and SBP. A flow rate of 20 gpm will be the design minimum flow rate and the flexibility to turn-down the treatment system to handle this flow will be incorporated into the initial design. More detailed information on the hydraulic capacity of each unit process is provided later in this document.

1.3.4. Design Influent Concentrations

The characteristics of the groundwater from each of the source streams were estimated based on samples from groundwater monitoring wells and Geoprobes. The information collected in the sampling program has since been supplemented with the results of the recent sampling and analysis that was performed in June 1995 as part of bench scale testing of advanced oxidation equipment. The recent sampling activity involved collecting groundwater samples from the existing pump test well and collecting Geoprobe groundwater samples from the SBP and OFCA. The characteristics of the source streams are presented in Table 1-2.

TABLE 1-2

PROJECTED INFLUENT CHARACTERISTICS

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Water Quality							
pH	Std Unit	6.7	6.7	6.45	6.30	6.32	5.81
Dissolved oxygen	mg/l	6.5	6.5	7.4	6.1		
Temperature	degree C	11.4	11.4	14.5	10.83		
Specific conductance	µmHos/cm	965	965	4,360	1,250		
Hardness, total	mg/l-CaCO3	670	670	1,366	688		
Residue, diss (TDS)	mg/l	853	853	6,410	1,328		
Residue, susp (TSS)	mg/l	125	125	967	25,367	12,400	391
Alkalinity, total	mg/l-CaCO3	455	455	1,913	473		
BOD	mg/l	16	16	36,533	2,420	8,370	14,700
COD	mg/l	111	111	139,567	4,090	79,500	26,000
Carbon (TOC)	mg/l	28	28	94,950	1,237		
Oil and grease (e)	mg/l	1.0	1.0	101,683	784	30,200	74

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.

(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.

(c) OFCA – Average value from three geoprobe samples.

(d) SBP – Average value from three geoprobe samples.

(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.

(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.

(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 1-2

PROJECTED INFLUENT CHARACTERISTICS
(CONTINUED)

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Anions							
Chloride	mg/l	28	28	996	146		
Nitrogen, TKN	mg/l as N	9.2	9.2	234	27.07		
Phosphorus, total	mg/l as P	0.1	0.1	1.00	2.22		
Sulfate	mg/l	268	268	336	110		
Cations							
Antimony	mg/l	0.002	0.002	0.094	0.014		
Arsenic	mg/l	0.025	0.011	0.026	0.018	0.046	0.028
Cadmium	mg/l	0.010	0.010	0.61	0.06	0.96	0.543
Calcium	mg/l	188	188	274	138		
Chromium, total	mg/l	0.010	0.010	1.19	0.037	2.23	0.05
Copper	mg/l	0.020	0.020	0.26	0.24	5.61	0.27
Iron	mg/l	15.0	15.0	1,527	246	489	386
Lead	mg/l	0.007	0.007	2.43	0.176	9.61	0.105

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 1-2

PROJECTED INFLUENT CHARACTERISTICS
(CONTINUED)

Constituents	Units	PGCS[a]	ONCA[b]	OFCA[c]	SBP[d]	50/50 SBP/OFCA Unsettled[e, g]	50/50 SBP/OFCA Settled[f, g]
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Cations (continued)							
Magnesium	mg/l	35	35	67.7	63.7		
Manganese	mg/l	0.960	2.380	NA	NA		
Mercury	mg/l	0.000	0.000	0.0025	0.0026		
Nickel	mg/l	0.020	0.020	0.54	0.097	2.09	0.78
Potassium	mg/l	6.2	6.2	31.01	11.43		
Selenium	mg/l	0.002	0.002	0.002	0.003		
Sodium	mg/l	NA	NA	604.8	38.8		
Thallium	mg/l	0.001	0.002	0.002	0.002		
Zinc	mg/l	0.063	0.063	164	1.39	33.1	19.0
Organics							
Acetone	µg/l	30	10	7,700	7,700	1,710,000	241,000
Benzene	µg/l	9,250	320	96,000	9,350	9,640,000	7,150
bis(2-Chloroethyl)ether	µg/l	50	10	340	803		

((a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 1-2

PROJECTED INFLUENT CHARACTERISTICS
(CONTINUED)

Constituents	Units	PGCS(a)	ONCA(b)	OFCA(c)	SBP(d)	50/50 SBP/OFCA Unsettled(e, g)	50/50 SBP/OFCA Settled(f, g)
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Organics (continued)							
bis(2-Ethylhexyl)phthalate	µg/l	10	10	11,037	2,213	320,000	120
2-Butanone	µg/l	10	10	15,000	15,000	974,000	272,000
Butyl benzyl phthalate	µg/l	10	10	10	40	27,000	10
Chloroethane	µg/l	750	700	3,100	3,100	1	230
Chloromethane	µg/l	2.5	2.5	2	2	<0.028	1,940
4-Chloro-3-methylphenol	µg/l	10	10	10	10		
1,2-Dichlorobenzene	µg/l	20	3	1	1	569,000	10
Diethyl phthalate	µg/l	10	10	10	97	<25,000	40
2,4-Dimethylphenol	µg/l	10	15	3,870	267		
Dimethyl phthalate	µg/l	10	10	267	10	<25,000	380
Di-n-butyl phthalate	µg/l	10	10	10	97	65,000	10
Ethylbenzene	µg/l	250	3	188,700	78,467	6,200,000	664
Isophorone	µg/l	10	10	20,833	740	77,000	10

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

TABLE 1-2

PROJECTED INFLUENT CHARACTERISTICS (CONTINUED)

Constituents	Units	PGCS(a)	ONCA(b)	OFCA(c)	SBP(d)	50/50 SBP/OFCA Unsettled(e, g)	50/50 SBP/OFCA Settled(f, g)
		March 1995	March 1995	March 1995	March 1995	June 1995	June 1995
Organics (continued)							
Methylene Chloride	µg/l	50	50	56,668	6,002	936,000	22,000
4-Methyl-2-pentanone	µg/l	10	40	14,000	14,000	2,900,000	29,600
4-Methylphenol	µg/l	10	10	560	560		
Naphthalene	µg/l	2	10	21,740	3,543	2,410,000	38
Phenol	µg/l	10	10	16,670	417		
Tetrachloroethene	µg/l	1.5	10	25,667	3,267	35,200,000	2,450
Tetrahydrofuran	µg/l	10	4,000	10	10		
Toluene	µg/l	300	300	27,064,000	336,000	31,400,000	22,600
1,1,1-Trichloroethane	µg/l					14,600,000	16,500
Trichloroethene	µg/l	10	1.5	23,067	4,667	7,650,000	3,670
Trichlorofluoromethane	µg/l	3	3	1	1	128,000	34
Vinyl chloride	µg/l	120	120	1	1	25,800	80
Xylenes, total	µg/l	5	5	1,011,000	395,000	35,000,000	1,400

(a) For organics, individual values from GWMW03 and GWMW14 were averaged with the average values from the pump test. For water quality parameters, metals and ions values are from pump test.
(b) For organics, individual values from GWMW04 were averaged with the average values from the pump test.For water quality parameters, metals and ions values are from pump test.
(c) OFCA – Average value from three geoprobe samples.
(d) SBP – Average value from three geoprobe samples.
(e) Sample consisted of a 50:50 mixture from OFCA and SBP areas. Samples collected by geoprobe.
(f) Sample consisted of the aqueous phase of a 50:50 mixture from OFCA and SBP areas that was settled for 24 hours. Samples collected by geoprobe.
(g) Geoprobe samples of 50/50 mixture collected on a different date than geoprobe samples comprising OFCA and SBP.

To design the treatment system, an influent profile was developed for each of the flow conditions (Stages 1 through 5) shown previously in Table 1-1. As expected, the high concentrations of contaminants in the SBP and OFCA significantly impact the quality of the influent. In fact, the high contaminant levels in these areas water greatly impact the selection and sizing of the treatment processes even when all groundwater streams are combined. There is, however, substantial uncertainty about whether or not the water quality data for these two areas are representative of what would actually be extracted from the planned dewatering systems. The uncertainty revolves around the following concerns:

- The data used to characterize these two source streams were from samples collected using the Geoprobe method. Samples collected using properly installed wells and developed extraction wells will likely have lower levels of solids, non-aqueous phase liquids, and other contaminants.

- The Geoprobe samples were taken in the more contaminated portions of the SBP and OFCA. The dewatering wells could be placed in less contaminated areas, therefore reducing the levels of contamination in the extracted groundwater.

- Given the heterogeneous nature of the materials disposed in the SBP and the OFCA, it is very difficult to obtain a representative sample.

Because of the uncertainty associated with treating groundwater from the SBP and OFCA, the following decisions were made:

- At a minimum, provide a phase separator for pretreatment of groundwater from the SBP and OFCA.

- When sizing the main treatment components, assume that the groundwater extracted from the SBP and OFCA naturally has "lower" levels of contaminants than the available data indicate. This is likely to be the case because the extracted groundwater will be a mixture of highly contaminated groundwater (represented by Geoprobe data) and groundwater from less contaminated areas. If this does not prove to be the case, then we will install additional pretreatment facilities to reduce the levels in these two streams before blending with the PGCS and ONCA streams. The "lower" levels of contaminants in the SBP and OFCA were estimated using the data from the settled sample in Table 1-2 and applying a 95 percent reduction for each constituent. The data from the settled sample is representative of the effluent from a phase separator and the 95 percent reduction should be representative of the effluent from a pretreatment process. The resulting concentrations will be used for the SBP and OFCA source streams when developing a flow-weighted average influent to the main treatment processes.

- Provide extra space to allow for the additional pretreatment facilities. The determination as to the need for the additional pretreatment facilities will be made after data are collected on the actual water extracted from the dewatering wells.

This approach offers the best potential for a flexible, and if necessary, expandable groundwater treatment system. By providing some capacity to handle the dewatering water, it affords the opportunity to startup the dewatering systems and collect data to characterize the actual water from dewatering. If the contaminant levels are as high as the Geoprobe data indicate, flow from the dewatering systems would be minimized or shutdown while the additional necessary pretreatment facilities were installed. If, on the other hand, the contaminant levels are much lower, additional treatment facilities may not be needed, and it may be possible to pump the dewatering systems at a higher flowrate.

Using the above assumptions, influent profiles were developed and are shown in Table 1-3 for the following conditions: (1) the combined SBP and OFCA groundwaters, (2) the stage 4 flow condition which represents the worst case contaminant loading (referred to as the design condition in Table 1-3), and (3) the stage 5 (long-term) flow condition.

TABLE 1-3

DESIGN INFLUENT CONCENTRATIONS

Constituents	Units	SBP/OFCA Groundwater[a]	Combined Groundwaters Design Condition[b]	Combined Groundwaters Long-Term Condition[c]
Flow	gpm	13	55	20
Water Quality				
pH	Std Unit	6.4	6.6	6.5
Dissolved oxygen	mg/l	0	0	0
Temperature	degree C	12	16	19
Specific conductance	µmHos/cm	3,164	1,470	1,819
Hardness, total	mg/l-CaCO3	1,105	772	842
Residue, diss (TDS)	mg/l	4,455	651	512
Residue, susp (TSS)	mg/l	1,000	152	171
Alkalinity, total	mg/l-CaCO3	1,359	667	813
BOD	mg/l	23,413	189	310
COD	mg/l	87,460	416	627
Carbon (TOC)	mg/l	58,907	104	157
Oil and grease	mg/l	30,000	1.9	2.6
Anions				
Chloride	mg/l	670	258	417
Nitrogen, TKN	mg/l as N	155	42	66
Phosphorus, total	mg/l as P	1.5	0.5	0.7
Sulfate	mg/l	250	263	261
Cations				
Antimony	mg/l	0.090	0.023	0.037
Arsenic	mg/l	0.030	0.019	0.027
Cadmium	mg/l	0.540	0.135	0.222
Calcium	mg/l	220	195	201
Chromium, total	mg/l	0.750	0.019	0.026
Copper	mg/l	0.300	0.086	0.132
Iron	mg/l	1,034	106	169
Lead	mg/l	1.500	0.029	0.044

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

TABLE 1-3

DESIGN INFLUENT CONCENTRATIONS (CONTINUED)

Constituents	Units	SBP/OFCA Groundwater[a]	Combined Groundwater: Design Condition[b]	Combined Groundwater: Long-Term Condition[c]
Cations (continued)				
Magnesium	mg/l	70	43	49
Manganese	mg/l	NA	NA	NA
Mercury	mg/l	0.0025	0.0007	0.0011
Nickel	mg/l	0.800	0.204	0.332
Potassium	mg/l	25	11	14
Selenium	mg/l	0.002	0.002	0.002
Sodium	mg/l	NA	NA	NA
Thallium	mg/l	0.0020	0.0019	0.0014
Zinc	mg/l	100	4.8	8.0
Organics				
Acetone	µg/l	125,000	1,489	2,518
Benzene	µg/l	63,000	2,311	5,750
bis(2-Chloroethyl)ether	µg/l	500	22.3	40.0
bis(2-Ethylhexyl)phthalate	µg/l	8,000	13.5	16.0
2-Butanone	µg/l	150,000	1,780	3,006
Butyl benzyl phthalate	µg/l	20.0	7.8	6.2
Chloroethane	µg/l	3,100	548	455
Chloromethane	µg/l	2,000	25.5	41.5
4-Chloro-3-methylphenol	µg/l	10.0	7.8	6.2
1,2-Dichlorobenzene	µg/l	10,000	124	212
1,1-Dichloroethane	µg/l	25,000	448	620
1,2-Dichloroethane	µg/l	66,000	78.5	126
1,1-Dichloroethene	µg/l	80.0	2.5	2.8
1,2-Dichloroethene-cis	µg/l	75,000	1,317	2,010
1,2-Dichloroethene-trans	µg/l	20.0	27.0	21.4
1,2-Dichloropropane	µg/l	300	4.7	6.9
Diethyl phthalate	µg/l	40.0	8.1	6.8
2,4-Dimethylphenol	µg/l	2,500	34.0	46.0

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SDP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

TABLE 1-3

DESIGN INFLUENT CONCENTRATIONS (CONTINUED)

Constituents	Units	SBP/OFCA Groundwater[a]	Combined Groundwater: Design Condition[b]	Combined Groundwater: Long-Term Condition[c]
Organics (continued)				
Dimethyl phthalate	µg/l	400	12.4	14.0
Di-n-butyl phthalate	µg/l	100	8.8	8.0
Ethylbenzene	µg/l	146,000	174	350
Isophorone	µg/l	13,000	7.8	6.2
Methylene Chloride	µg/l	37,000	298	470
4-Methyl-2-pentanone	µg/l	30,000	379	606
4-Methylphenol	µg/l	560	13.5	16.0
Naphthalene	µg/l	15,000	11.8	11.2
Phenol	µg/l	10,500	126	206
Tetrachloroethene	µg/l	17,000	35.3	50.9
Tetrahydrofuran	µg/l	10.0	2,184	6.2
Toluene	µg/l	16,784,000	525	680
1,1,1-Trichloroethane	µg/l	17,000	203	346
Trichloroethene	µg/l	16,000	50.3	86.0
Trichlorofluoromethane	µg/l	30.0	2.6	2.4
Vinyl chloride	µg/l	80.0	92.6	73.6
Xylenes, total	µg/l	775,000	27.5	43.0

(a) High-strength influent to phase separation. Flowrate of 13 gpm includes on 8 gpm from OFCA and 5 gpm from SBP.
(b) Design Condition assumes contaminant levels in the OFCA and SDP will actually be 95% lower than Geoprobe data show. Flowrate of 55 gpm includes 12 gpm from PGCS, 30 gpm from ONCA, 8 gpm from OFCA and 5 gpm from SBP.
(c) Long-Term Condition assumes contaminant levels in the OFCA and SBP will actually be 95% lower than Geoprobe data show. Flowrate of 20 gpm includes 12 gpm from PGCS, 5 gpm from OFCA and 3 gpm from SBP.
NA Not available.

1.4 TREATMENT CONSIDERATIONS

1.4.1. Effluent Quality Criteria

In accordance with the ROD, effluent from the treatment system will be discharged to the adjacent wetlands. Although a discharge permit is not required (see Section 3), the substantive requirements of a permit, such as effluent standards, need to be met. For discharges to the wetlands at the ACS Site, IDEM has issued the effluent limits presented in Table 1-4.

1.4.2. Process Air Emissions Criteria

Although no IDEM permit is required for air emissions control, the PGCS treatment facility must provide adequate emissions control of potential toxic vapors to the atmosphere. All equipment which has the potential of emitting contaminated air must include provisions for control of these potential emissions.

1.4.3. Sludge and Product Disposal Criteria

Residual solids generated by the PGCS treatment facility may be subject to the hazardous waste disposal regulations, if classified as a hazardous waste. Sludge produced at the facility will be characterized using the Toxicity Characteristics Leaching Procedure (TCLP) to determine its status as a hazardous waste. If solids are determined to be nonhazardous, they will be disposed by landfilling in an approved facility after securing the necessary disposal permits. If the residuals are found to be hazardous they will be disposed in an approved hazardous waste disposal facility using a hazardous waste disposal contractor.

Nonaqueous phase liquid (NAPL) will be handled similarly to the sludge. Based on screening analysis results of the NAPL, the NAPL reclaimer will determine the ultimate disposal method.

1.5 MANUAL USE AND ORGANIZATION

This Operations and Maintenance (O&M) Plan and the Contingency Plan for the PGCS treatment facility is designed to provide the plant operator with proper background and

TABLE 1-4

FINAL FPDES NUMBERS FOR DISCHARGE TO NO FLOW WETLANDS

Constituent	Units	Effluent Limitation
General Water Quality Parameters		
BOD5	mg/l	30
TSS	mg/l	30
pH	s.u.	6 to 9
Inorganics		
Arsenic	µg/l	50
Cadmium	µg/l	4.1
Mercury	µg/l	0.02 w/DL=0.64[a]
Selenium	µg/l	8.2
Zinc	µg/l	411
Volatile Organics		
Benzene	µg/l	5
1,2-Dichloroethene-cis	µg/l	70
Ethylbenzene	µg/l	34
Methylene chloride	µg/l	5
Tetrachloroethene	µg/l	5
Trichloroethene	µg/l	5
Vinyl chloride	µg/l	2
Semi-Volatile Organics		
Acetone	µg/l	6,800
bis(2-Chloroethyl)ether	µg/l	9.6
bis(2-Ethylhexyl)phthalate	µg/l	6
2-Butanone	µg/l	210
Isophorone	µg/l	50
4-Methyl-2-pentanone	µg/l	15
4-Methylphenol	µg/l	34
Pentachlorophenol	µg/l	1
PCBs		
PCBs	µg/l	0.00056 w/DL=0.1[a]

(a) Concentration shown is the effluent limitation, but analytical results showing less than the detection limit shown will be considered as in compliance.

procedures for day-to-day operation and maintenance of the treatment facility. The manual includes:

- An overall description of the treatment facility

- A description of the major treatment components and support systems

- Start-up procedures including water testing and actual start up of the PGCS treatment system with groundwater

- Individual equipment descriptions, identifying major components, procedures, process control provisions (where applicable), trouble-shooting, and preventive maintenance information

- Analytical program and record keeping and reporting

- Emergency response and contingency plan including the vulnerability analysis and alternate operations.

It should be emphasized that specific maintenance information on each piece of equipment will be provided in the manufacturer's O&M manuals for the individual equipment which will become addendum to this manual.

2.0 TREATMENT FACILITY DESCRIPTION

2.1 OVERVIEW

Based on the influent profiles, the suite of contaminants in the groundwater from the ACS site requiring removal prior to discharge varies considerably depending on which flow conditions are selected (see Table 1-2). The major contaminants in the PGCS and ONCA groundwater include iron, and a limited number of aromatic and chlorinated solvents such as benzene, ethylbenzene, tetrachloroethene, trichloroethene, vinyl chloride, bis(2-chloroethyl)ether, and bis(2-ethylhexyl)phthalate that are present at low concentrations. The major contaminants in the high-strength SBP and OFCA groundwaters include TSS, COD, BOD, TOC, nonaqueous phase liquids (NAPL), iron and other metals as well as wide variety of individual volatile and semivolatile organic compounds as listed in Tables 1-2 and 1-3.

Based on an evaluation of applicable treatment processes, a multi-process treatment train was selected for implementation at the site. The selected treatment train incorporates the necessary facilities to reduce all of the constituents to the appropriate discharge levels. Given the uncertainty regarding the levels of contaminants in the SBP and OFCA, however, it is recommended that some of the components not be installed at this time. Once data are available on the actual water extracted from the dewatering system, a determination can be made regarding the need for and appropriate sizing of these components. For completeness, these components are discussed in the following text, but they are labeled as "future" facilities and the text describing them is highlighted by italics. It should be noted that the selection of future facilities is contingent on future information that will be collected on the quality and treatability of the source water. Therefore, the actual future facilities that may be intalled could be different from the facilities described in this document.

Preliminary treatment consists of an phase separator to remove suspended solids and NAPLs, and a pretreatment equalization tank. Main treatment is provided by an equalization tank, UV Oxidation System for treatment of organic constituents, Chemical Precipitation Unit to remove heavy metals, Upflow Sand Filter for solids removal, Activated Carbon Units for final polishing of the toxic organics in the groundwater, pH Adjustment to meet the discharge standards, and solids collection and dewatering.

The system also includes a process air collection system which directs all contaminated air emissions from the process vessels to an Activated Carbon unit for treatment.

Refer to Appendix I for the Process and Instrumentation drawings and the mechanical layout of the PGCS facility.

2.2 TREATMENT REQUIREMENTS

The process train selected for treatment of the ground water will incorporate the necessary facilities to reduce all identified constituents to appropriate discharge levels. The major components of the process train are described below.

- **Reduction of Non-Aqueous Phase Liquids (NAPLs).** The treatment system will incorporate pretreatment of the high-strength groundwaters for removal of free phase organic constituents prior to blending with the lower strength PGCS and ONCA groundwater. A phase separation unit will be used for removal of NAPLs. Further removal of dissolved organic material (not removed by phase separation) will occur during treatment in the subsequent UV oxidation system and carbon adsorption units.

- **Reduction of Suspended Solids.** Initial removal of suspended solids will occur in the phase separator. Solids will be further removed via entrapment by floc in a metals precipitation process which will be followed by sedimentation and filtration.

- **Reduction of Iron and Other Metals.** Dissolved iron will be oxidized in a UV oxidation process and the resulting precipitate will be removed in the chemical precipitation process. Other heavy metals will also be precipitated in the chemical precipitation process which will be followed by sedimentation and filtration.

- **Reduction of Dissolved Volatile and Semi-Volatile Organic Compounds.** Dissolved organics will be destroyed using a UV-peroxide oxidation process. Carbon adsorption columns will be provided for effluent polishing and they will be used on an as-needed basis. If necessary in the future, a pretreatment system will be added to reduce dissolved organic material in the high-strength groundwaters from the site. Following pretreatment, the high-strength groundwater will be blended with the low-strength groundwater and the residual organic constituents will be removed in the UV oxidation system.

- **Reduction of COD, BOD, and TOC.** Reduction of COD, BOD and TOC will occur along with the reduction of NAPLs, suspended solids and organic constituents using the processes described above.

The system that will be installed initially will contain all of the equipment necessary to treat the maximum flow rate (60 gpm) with the organic, metals and suspended solids concentrations listed for the "design condition" combined influent (Table 2-3). The initial equipment to be installed also includes phase separation and oil storage tanks for up to 13 gpm from the SBP and OFCA. Additional space will be provided, and piping will be installed so that additional pretreatment equipment can easily be installed. Space would also be provided for an additional phase separator for treatment of high-strength influent should additional phase separation capacity be needed in the future.

2.3 PRETREATMENT FACILITIES

The purpose of the pretreatment facilities is to remove excess oil & grease and dissolved organic constituents in the high-strength influent from the OFCA and SBP areas to levels that (1) are commensurate with the low-strength wastewater from other areas of the site, (2) do not interfere with the main treatment processes, and (3) that can be consistently treated to meet the effluent discharge standards.

2.3.1. Phase Separator

Prior to being conveyed to the main treatment system, the high-strength groundwater from the OFCA and SBP will be pretreated in a phase separator to remove free phase NAPLs and other organic constituents that are present above their solubility limit. Some of the heavier suspended solids will be removed as well. Geoprobe samples from both areas have been shown to contain significant amounts of free phase material, and in bench scale testing, this material has been shown to be readily separable. The low-strength groundwater from the PGCS and ONCA also has the potential for having trace amounts of free phase material, and therefore, the necessary piping will be provided to route this stream through the phase separator as well.

2.4 MAIN TREATMENT FACILITIES

The main treatment system contains the facilities necessary to provide for flow equalization, organics removal, metals removal, solids removal, and solids handling. Low-strength groundwater from the PGCS and ONCA will be pumped directly to the main influent equalization tank where it will be blended with effluent from the high-strength groundwater pretreatment system. The groundwater will then be pumped to a UV oxidation system which will treat dissolved organic contaminants. Effluent from the oxidation system will flow to a metals removal system consisting of precipitation, flocculation and settling. Effluent from metals removal system will flow through a sand filter for removal of residual suspended solids. If needed, the flow will be pumped through GAC units to remove specific organic compounds prior to discharge. A sludge storage and dewatering system will be provided. The process units and their functions are described in the following section.

The system consists of five main treatment processes: UV oxidation, chemical precipitation, sedimentation, filtration and carbon adsorption as well as influent equalization and pH adjustment. Refer to Appendix I for the Process and Instrumentation drawings which illustrate the relationship between the various unit processes and their control mechanisms.

2.4.1. Influent Storage and Equalization

To provide sufficient blending and equalization of the influent streams, 80 minutes of equalization capacity at a flow of 60 gpm will be provided. The equalization tank will receive low-strength groundwater directly from the PGCS and ONCA and pretreated effluent from the high-strength groundwater pretreatment system. The tank will be supplied with a mixer to blend the two groundwaters and will function as a wetwell for the influent feed pumps for the main treatment processes.

2.4.2. UV Oxidation System

The UV oxidation system provides destruction of the organic components in the groundwater by oxidation of the organic carbon to carbon dioxide and innocuous byproducts such as simple dibasic acids. Halogens such as chloro and bromo substituents are converted to salts. The system uses hydrogen peroxide as the main source of oxidizing potential. Both high intensity UV light and reduced iron salts are used as catalysts. The main oxidizing species created by the process are hydroxyl radicals which form from the decomposition of peroxide by the two catalysts. Oxidation of the organic material and reduced iron in the influent stream will be accomplished by injecting sulfuric acid and hydrogen peroxide. The water will then pass through a reactor containing high intensity ultraviolet lamps. The UV light and reduced iron in the water will catalyze the decomposition of the peroxide into hydroxyl radicals which subsequently attack and destroy dissolved organic material. Ferrous sulfate will also be injected if an additional source of iron is needed, however it use on a regular basis is unlikely because of the relatively high reduced iron content of the groundwater at the site. Some decomposition of organic material will also result from the direct effect of UV light and peroxide which are also oxidizing agents, although they are less powerful than hydroxyl radicals. The reduced iron will also be oxidized in the process and will form an insoluble precipitate upon adjustment of the pH following the reaction.

Effluent from the oxidation process will flow to the metals removal system for removal of iron, and other metals. Suspended solids will also be removed in the metals removal system. The oxidation system will be controlled by a programmable logic controller (PLC) provided by the equipment vendor. The PLC will control the chemical feed systems based on flow (peroxide and ferrous sulfate dosing) and pH (acid addition), and will control the UV light intensity based on flow. Peroxide, sulfuric acid, and ferrous sulfate will be added using chemical metering pumps to precisely control the dosages. Bulk storage tanks will be provided for 50 percent peroxide solution and 93 percent sulfuric acid. Ferrous sulfate will be fed from 55 gallon drums.

2.4.3. Metals Removal System

Oxidized iron, other metals, such as lead, zinc, nickel, copper and chromium, and suspended solids in the effluent from the oxidation system will be removed in a chemical precipitation unit. The unit will consist of a rapid mix tank in which the pH will be raised to the desirable level (approximately 10 s.u.), a flocculation tank, and a plate settler (lamella clarifier) with an internal sludge thickener. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustments. The acid feed system will utilize the bulk storage tank previously described as part of the oxidation systems. A bulk storage tank will also be provided for 50 percent sodium hydroxide solution. Liquid polymer will be used to aid in coagulation and flocculation of the metal precipitates and suspended solids. The polymer feed system will consist of a metering pump and a polyblend mixing system. Emulsion polymer (approximately 30 percent solution) will be fed from a day tank (55 gallon drum) and will be diluted to approximately one percent by the polyblend system before being fed to the rapid mix tank. Sludge from the settler/thickener unit will be pumped to a sludge storage and thickening tank. Effluent from the settler will flow by gravity to the upflow sand filtration unit.

2.4.4. Sand Filtration

The residual suspended solids in the metals precipitation unit effluent will be removed using an upflow, continuous backwash sand filter. A continuous backwash filter was chosen over conventional gravity sand filters or pressure sand filters to eliminate the need for a backwash cycle and the associated storage facilities and pumps. Operator attention requirements are also reduced with a continuous backwashing system. Influent to the filter will flow by gravity from the Lamella clarifier. The filter influent will have enough gravity head to pass through the sand bed and into the pH adjustment tank (following the filter) without the need for pumping. Continuous backwash will be provided using an airlift pump, which will pump a small percentage of flow containing the filtered solids from the system. Filter backwash water will flow to the filtrate, decant water and backwash sump prior to being returned to either the phase separator or the main equalization tank.

2.4.5. pH Adjustment

The pH of the effluent from the metals removal system and sand filter will be adjusted between 6 and 9 s.u. for final discharge. pH adjustment will be accomplished in a tank which will be equipped with a mixer, pH probe and a controller. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustments. Acid and base will be provided from the bulk storage tanks previously described. The pH adjustment tank will also serve as a wetwell for the effluent pumps which will convey effluent through the GAC contactors or directly to the effluent sump and weir box. The effluent pumps will be sized to pump against the total head associated with GAC system and elevated effluent sump and weir box.

2.4.6. GAC Contactors

If the final filtered effluent contains specific chemical constituents in concentrations above the allowable discharge goals, the flow will be routed through GAC contactors for additional treatment. Under normal operating conditions, the use of GAC for effluent polishing is not expected to be necessary. The GAC system will function as a backup system to the other treatment processes should upsets, failures or unexpected problems arise with those systems. The GAC system will also be used during startup to ensure the effluent limits are achieved. The GAC contactor system will be a vendor supplied package consisting of two contactor units. The system will have the capability to operate in either parallel or series mode depending on the particular treatment needs. Each column will however have the hydraulic capacity to pass the maximum flow from the treatment plant. Replacement of the carbon will need to be conducted periodically when the adsorption capacity has been exhausted. Spent carbon will be replaced by the carbon system supplier (in conjunction with the plant operators). Carbon exhaustion will be determined by effluent sampling and analysis, and by operator experience. Flow to, and through, the GAC system will be controlled by manually adjusting the proper valves.

2.4.7. Effluent Sump and Weir Box

Treated water will flow into the effluent sump and weir box either directly from the pH adjustment tank or from the GAC contactors. The sump will consist of a mixing chamber, baffle wall, stilling chamber, and a V-notch weir. Flow will enter the mixing chamber at which point the pH will be continuously monitored and adjusted to ensure it is within the desirable range for discharge (6 to 9 s.u.). Acid and base feed systems will be provided for pH adjustments. After pH monitoring and adjustment, the flow will pass through a baffle wall and into the stilling chamber. Flow will pass through the stilling chamber and over a V-notch before entering the final discharge pipe. An ultrasonic gauge will continuously measure the water level in the stilling chamber. The ultrasonic gauge will convert the water depth in the stilling chamber to flow rate and provide a local display. The gauge will also be connected to a strip chart recorder for continuous monitoring and recording of discharge flow. A staff gauge will be provided for manually calibrating the ultrasonic flow meter. A flow paced effluent sampler will collect either grab or composite samples from the stilling chamber via an effluent sample line. Discharge from the effluent sump and weir box will flow by gravity to the wetlands diffuser system for final discharge. A recycle line will be provided from the effluent sump to the filtrate, decant backwash sump so that effluent can be recycled to the head of the plant during startup of the treatment system.

2.4.8. Sludge Handling and Disposal System

The sludge disposal system provides a means to accumulate and concentrate metals sludge and pretreatment system sludge prior to dewatering for off-site disposal. The elements of this system are: a mixed sludge storage and thickening tank, polymer feed system, plate and frame filter press, and sludge transfer pumps.

Sludge from the metals precipitation system and from the phase separation tanks will be pumped to sludge storage tanks. Initially, one sludge storage tank will be provided for metals sludge. A second sludge storage tank will be provided for storage of sludge from the phase separator prior to initiating dewatering of the OFCA and SBP areas. Sludge will be allowed to settle and thicken in the storage tanks prior to dewatering. The sludge storage tanks will be equipped with multiple decant ports for the removal of free water. The decant ports will discharge to a pipeline carrying waste liquids to the filtrate, decant, and backwash sump. The decant discharge line will be provided with a sight glass so that the plant operator can assess the quality of the liquid withdrawn. Thickened sludge from the metals storage tank will be pumped to the filter press for dewatering. Thickened sludge from the phase separator storage tank will be either dewatered or hauled off-site in a liquid form depending on its characteristics. Polymer addition for sludge conditioning will be provided by a metering pump. Liquid emulsion polymer (approximately 30 percent) will be fed directly from 55 gallon drums into the influent to the filter press. An inline mixer will be provided for blending. Filter cake from the press will drop into a roll-off dumpster and will be periodically transported off-site for disposal.

2.5 FACILITY SUPPORT SYSTEMS

2.5.1. Air Handling System

Those process units that have the potential to generate off-gas or solvent vapors will be covered and vented to an air collection system. The process units which will be connected to the air collection system include:

- Phase separators (1)
- Equalization tanks (2)
- Oil storage tank (1)
- Sludge storage tanks (2)
- Filtrate, decant water, backwash sump (1).

Tanks needing vents will be connected to a vapor phase carbon bed prior to venting to the atmosphere. The volatile organics in the influent groundwater will be destroyed in the main UV oxidation system, and therefore, downstream processes such as such as metals removal, sand filtration, pH adjustment and GAC adsorption will not be vented. These processes will be open to the building atmosphere. The filter press area will be vented to the outside and the roll-off dumpster will be located in a separate enclosed area which will also be vented to the outside.

Condensate in the air vent lines will be collected in a moisture trap which will be located upstream of the vapor phase carbon bed. Liquid that is collected will flow to the filtrate, decant water, and backwash sump.

2.5.2. Instrumentation and Control Systems

The PGCS treatment facility is equipped with sophisticated instrumentation and control systems which provide a high degree of automation while maintaining a safe operational environment for the facility. In essence, the overall system is controlled by a Programmable Logic Controller (PLC), located at the Electrical/Instrumentation Room. Major process units such as UV Oxidation Systems, Chemical Precipitation Unit, Upflow Sand Filter, and Filter Press will be operated via individually dedicated vendor PLCs. Other main treatment components such as oil-water separator and GAC units are hydraulically controlled by the facility flow conditions. Alarm signals for liquid levels, pH and pressure are communicated to the Main Control Panel and/or the PLC to activate/deactivate process equipment, and ensure continuity of the process flow throughout the treatment system.

Although the PGCS treatment facility components are controlled primarily by the PLC, the process control responsibility is assigned to the facility operator. The Operator's duty is to monitor and adjust the process parameters of the individual treatment components and to designate the process flow through the treatment stages, based on the analytical characterization of the groundwater and the process control information.

2.5.3. Compressed Air System

Compressed air at the PGCS treatment facility is supplied via an on-site air compressor located at the Mechanical Equipment Room, for use by the air operated diaphragm pumps, filter press pneumatic system, air scouring system for the upflow sand filter and instrumentation air.

2.5.4. Facility Water Supply

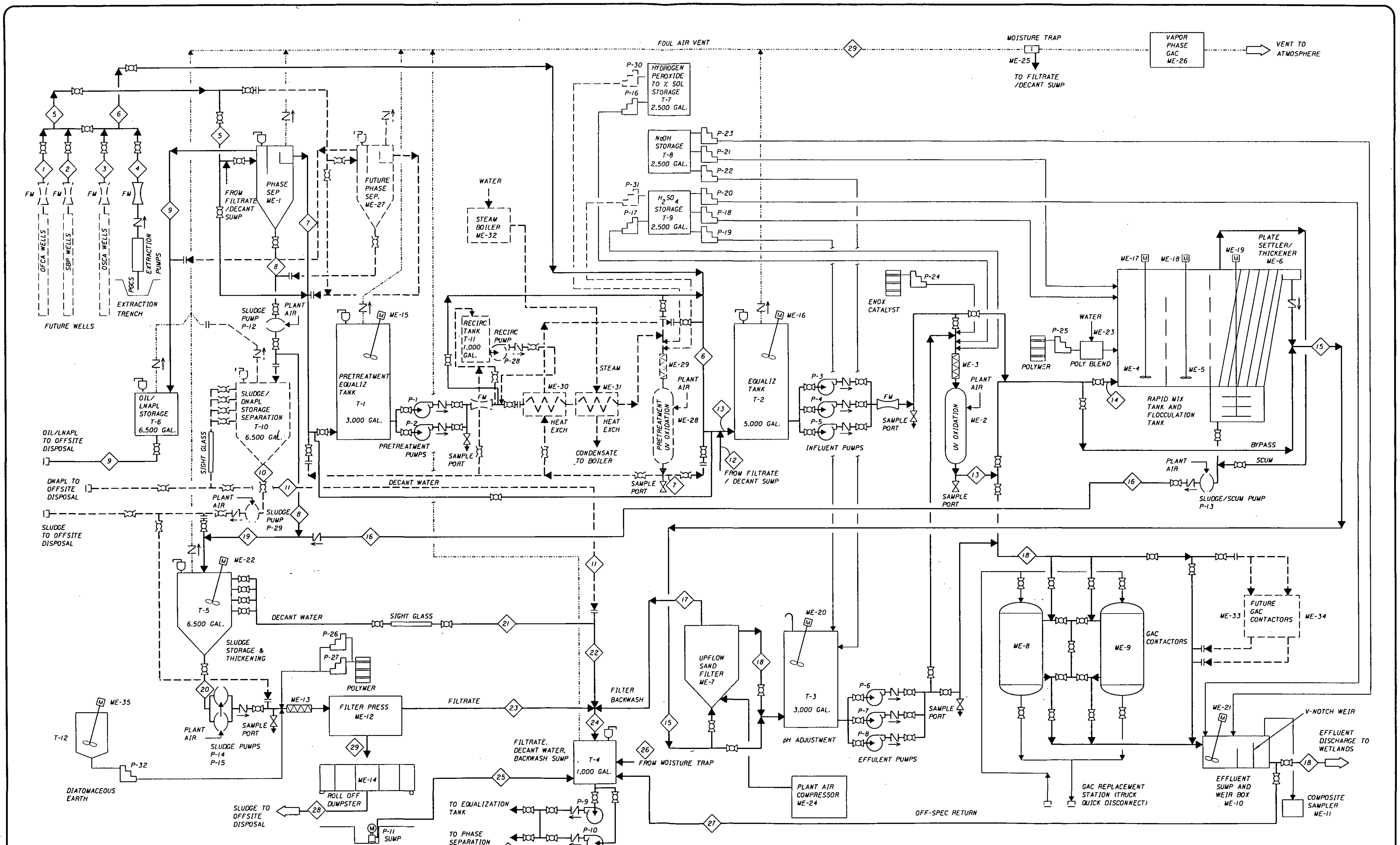
Service water for the PGCS treatment facility will be supplied from the City's potable water system. Permit requirements for the City water line to the PGCS treatment facility will be identified later.

2.5.5. Sumps

The secondary containment system at the PGCS treatment facility is equipped with sump collection systems to direct the collected water to the appropriate tank.

A main process sump will be provided to collect reject water from all of the unit processes, and from the floor sumps within the building containment structure. The water collected in the sump will be returned to either the influent line to the phase separator or to the main treatment system equalization tank at the discretion of the plant operator.

Two floor sumps will be provided in the building containment area to collect spills and washdown water. Any water collected in the sumps will be manually returned to the main process sump using a portable sump pump. A floor sump will also be located beneath the roll-off dumpster to collect drainage from the dewatered sludge and washdown water from the sludge storage pad. This sump will be equipped with a level controlled sump pump which will return water to the main process sump.



MONTGOMERY WATSON

Salt Lake City, Utah

PROCESS FLOW & MASS BALANCE

FIG 2-1

acs_fig 2-2.dgn (09/14/95)

3.0 FACILITY START UP

3.1 OVERVIEW

This section discusses the start-up program and performance testing of the PGCS. These procedures are also applicable for future start up, if applicable. Prior to start up, the PGCS operations staff will be trained in facility O&M procedures and assume the operational responsibilities at the time ground water is introduced into the PGCS.

The start-up activities involve three stages:

- Facility Water Test including individual equipment testing and calibration, and the system water test.
- Performance test of PGCS at the design flow conditions.
- Process adjustment, to tune facility operations back to the current flow conditions.

This section describes the start-up procedures for the overall facility, in accordance with the activities specified above. Detailed start-up procedures for the individual equipment are included in Sections 3.0, 4.0, and 5.0 of this document.

3.2 WATER TESTING PROCEDURES

Before initial start up, all equipment will be checked and mechanically tested to ensure that each piece of equipment is water tight or air tight and has no faulty mechanical parts. Each vendor- and engineer-provided control program will be tested before and after installation. Each control loop will be tested according to signal and control logic. In addition to the individual equipment testing, a system water test will be performed to ensure the integrity of the PGCS as a whole.

3.2.1 Individual Equipment Test

A clean water test will be conducted on each process unit and on the overall integrated PGCS. The main purpose of the clean water test is to test the function of each process component. All controls, alarms, valves, pumps, and motors will be verified for proper function. The functional test requirements for the major components of the PGCS are listed below.

Extraction Trench	Pump control, flow meter
Phase Separator	NAPL level, solids pump-out level, discharge level
NAPL Storage Tank	Level indicator
Sludge Storage/Thickening Tank	Level indicator, mechanical mixer
Equalization Tanks	Level control
Heat Exchangers	Steam flow, temperature indicators
UV Oxidation Units	UV lamps, vendor PLC, chemical addition, catalyst addition
Chemical Precipitation Unit	Vendor PLC, pH control loop, flow/level control
Filter Press	Vendor PLC, polymer feed control, sludge pumps
Upflow Sand Filter	Vendor PLC, air and water flow control, backwash control
pH Adjustment Tank	Level control, pH control loop
GAC Contactors	Lead/lag system, backwash control, pressure control
Effluent Sump and Weir Box	Mechanical mixer, pH control, flow level, head over the weir, composite sampler
Sump	Sump pump control
Process Air System	Process air collection, flow rate, moisture trap

Plant water will be used for the clean water test and shall be recycled as much as possible.

3.2.2 System Water Test

At the conclusion of the Individual Equipment Test, the entire PGCS will be tested with clean water. A design flow of 60 gpm will be provided at the Phase Separator, and flow through each component according to the Process Flow Diagram (Appendix I) for a period of at least 48 hours. Each piece of equipment and connecting piping will be inspected for integrity and leakage. The instrumentation and control system will be tested in the design operating mode. Adjustment and recalibration of the field instrumentation system will be performed as needed. During the clean water test, clean water will be released from the effluent weir box through the effluent pipe and diffuser system to test the discharge system.

After the clean water test is completed, all tanks and equipment will be reset to the start-up conditions as specified by the manufacturer's equipment manuals. All valves and control settings will be checked for correct position. All pumps, blowers, motors, and moving parts will be checked for proper lubrication.

3.3 FACILITY START UP

Once the Water Test is successfully completed, the facility start-up operation will commence. During the initial stage of the facility start up, efforts will focus on acclimation of the individual systems to the PGCS ground water.

3.3.1. Critical Components

Although all treatment components are essential to maintain the operating conditions of the facility, a few major components are most critical for achieving the treatment goals. The significance of these systems is vital during start up of the PGCS and include Phase Separator, UV Oxidation system, and the Chemical Precipitation Unit.

The Phase Separator must remove the majority of the NAPL from the ground water. The NAPL can interfere with and overload the performance of the main treatment systems. It is, therefore, essential that NAPL separation at the Phase Separator is effective and also that all streams containing even a trace amount of NAPL be diverted to this pretreatment system.

The UV Oxidation system is the main treatment unit for organic removal. The UV lamps in the UV Oxidation system and the chemical feed rates have to be tuned not only to the flow rate but also to the incoming concentration of contaminants. The success of the PGCS treatment depends on the operation of the UV Oxidation system. It is, therefore, critical to carefully adjust the UV Oxidation system during the start-up phase.

The Chemical Precipitation Unit forms the main treatment for metals carried by the ground water. Inadequate performance of the Chemical Precipitation Unit could interfere with the subsequent treatment systems and cause non-compliance with the discharge standards.

Obviously the performance of these three critical systems will impact the effectiveness of the secondary treatment systems and the polishing units to the required discharge standards. The plant start-up procedures will emphasize these systems to ensure that the PGCS meets the design performance, as described in the design specifications.

3.3.2. Operating Procedures - Start Up

3.3.2.1. Water Level Measurements. Prior to the actual startup of the facility, baseline water level information for the trench and surrounding areas should be collected over a time period of several months. This water level information is necessary to allow assessment of the drawdown in the trench. Water levels should be measured in the trench piezometers, in nearby piezometers (those that will be installed 25 feet up and down gradient from the trench, and existing piezometers near the trench [P-23 through P-27]) and in reference piezometers far upgradient from the trench. Upgradient piezometers include P-31, P-40 and P-41.

3.3.2.2. Extraction Trench. The initial step in the facility start up involves turning on the sump pump in the Extraction Trench. The influent valves to the treatment facility should be open to ensure flow of water to the facility. Once the ground water starts to flow through the conveyance piping, the pump should be adjusted for the desired flow rate (approximately 40 gpm). The flow rate should be readjusted periodically so that a water level drawdown of one foot less than ambient (referenced against the levels measured in P-31, P-40 and P-41) is achieved.

3.3.2.3. Preliminary Treatment. The Phase Separator will be initially filled with water at the start of pretreatment to ease the separation of NAPL once ground water in introduced. As ground water flows into the Phase Separator, the level in the Phase Separator will start to build up to allow for gravity flow over the overflow weir and into the Influent Equalization Tank. All components of the Phase Separator will be set to operate in the automatic mode. The skimmed NAPL should start to flow into the NAPL Storage Tank.

Refer to Section 3.3.3 for process control procedures during the start-up phase.

3.3.2.4. Primary Treatment. Start up of the main PGCS will not commence until adequate storage at the Influent Equalization Tank and the Intermediate Equalization Tank is available for continuous operations of the main treatment stages. At a minimum the Influent Equalization Tank and the Intermediate Equalization Tank each will be half-full, for a total ground water storage volume of 4,000 gallons.

Introduction of the ground water to the UV Oxidation system will be done gradually. All connecting valves will be checked to ensure proper position and seating. The influent pumps will be started initially and throttled down to the desired flow rate. Since the pretreatment UV Oxidation system is for the future phase and will not be installed initially, the pretreatment pump valves will be positioned to direct the ground water to the Main Equalization tank. Once the ground water flow to the Main Equalization tank is established, the influent pumps will be started. The influent pumps will be subsequently throttled down to the desired flow rate. Prior to start of the influent pumps, check and ensure that the UV lamps in the Main UV Oxidation system are on and ready for operations.

The chemical feed systems for the UV Oxidation system will be operated in the automatic position throughout start up. Close monitoring of the feed systems, to ensure proper operation will also be performed.

Partially treated ground water from the UV Oxidation system will be pumped to the Chemical Precipitation Unit. This transfer should be conducted in the automatic mode. During the start up, the Chemical Precipitation Unit will be checked to ensure automatic start of the mechanical mixers, and the chemical feed system based on the pH control loop. The mechanical mixers in each compartment of the Chemical Precipitation Unit will be timed to ensure proper functioning of the whole unit.

Refer to Section 3.3.3 for process control procedures during the start-up phase.

3.3.2.5. Secondary Treatment. The effluent from the Chemical Precipitation Unit will gravity flow through the Upflow Sand Filter and into the pH Adjustment Tank. All valves should be positioned to allow automatic transfer of the ground water through the sand filter. The pressure loss through the sand filter should be noted during the start-up phase.

The chemical feed system and the intermediate pumps associated with the pH Adjustment Tank will be operated in the automatic position throughout start up. Close monitoring of the feed systems, level control in the pH Adjustment Tank, and the influent pump operation will also be performed to ensure proper operation.

The effluent pumps will transfer ground water from the pH Adjustment Tank to the GAC Contactors for treated ground water polishing. The GAC Contactors will be checked for series and parallel operations during the start-up phase. This operation will be conducted manually be changing the valve position appropriately. The pressure loss through each Contactor will be noted during the start-up phase.

During start up, the backwash operation of the Upflow Sand Filter will be adjusted. Once water is flowing through the unit, the air flow control valve will be adjusted so that a backwash discharge rate of 2 gallons per minute is achieved. Discharge rate will be measured over the backwash discharge weir. After a period of operation the plant operator may have to readjust the backwash rate based on the solids loading to the filter unit.

Refer to Section 3.3.3 for process control procedures during the start-up phase.

3.3.2.6. Effluent Sump and Weir Box. The effluent sump will be filled with treated ground water. The level in the effluent sump and flow over the weir will be noted to endure proper operation of the discharge facilities. Analytical testing will be performed using the composite sampler and on-site testing facilities prior to discharge. Operation of this system will not vary from routine O&M procedures described later in this document.

3.3.2.7. Sludge Dewatering. Sludge dewatering activities will not be conducted during the start-up phase due to the small quantity of sludge available for this operation. When sludge dewatering operations are required, the mode of operation will be similar to normal operating mode, that is, decanting operation of the Sludge Storage Tanks will be manual, and Filter Press operation will be in the "push-button start" mode with an automatic shut off.

3.3.2.8. Process Air Treatment. The vapor-phase GAC will be operated in the automatic mode. The flow meter will be checked and calibrated during the start-up phase. Samples will be collected from the GAC effluent for analyses per the air discharge standards.

3.3.2.9. PGCS Support Systems. In general, the support systems (air compressor, chemical feed systems, etc.) will be operated in the auto mode, via the PGCS PLC system. During start up, it is anticipated that several operations will be manually controlled and adjusted, in response to the conditions of the incoming ground water and the status of individual components.

3.3.2.10. Wetland Discharge System. Prior to start-up of the treatment system, the valves located in diffuser system valve vault should be adjusted so that they are in the fully open position. This will ensure that treated effluent will flow to the wetland and will not back up into the effluent weir box.

3.3.3. Process Control

This program identifies the significant process control criteria for evaluating the process efficiency as it is adjusted to the PGCS ground water. Two types of process control criteria are discussed below for each component of the treatment facility:

- Process control parameters
- Analytical testing

3.3.3.1. Extraction Trench. The extraction trench provides containment of the ground water at the ACS site. In order to assure containment of the site water a water level drawdown of one foot below ambient should be maintained in the trench. To monitor the drawdown, water levels in the trench piezometers, nearby up and down gradient piezometers and in reference piezometers (P-31, P-40 and P-41) should be measured.

3.3.3.1. Phase Separator. The Phase Separator serves as the pretreatment system of the PGCS, responsible for removal of free oil and grease from ground water prior to entering the main facility. The process control parameters for the this system are:

- NAPL removal efficiency
- Suspended solids removal efficiency

In order to monitor these parameters the following analytical tests are required:

- Influent: NAPL, total suspended solids (TSS)
- Effluent: NAPL, TSS

3.3.3.2. Influent Equalization. The pretreated ground water enters the Influent Equalization Tank and is stored for primary treatment through the UV Oxidation system. It is necessary, at this stage, to (1) characterize the influent ground water composite in order to ensure that the NAPL and TSS are adequately removed, (2) ensure that no contaminants are present that may interfere with the UV Oxidation system treatment, and (3) to adjust the process parameters of the chemical feed system and the UV Oxidation system to the incoming flow. Ground water characterization will include the following analytical parameters:

- General organics - BOD, COD, TOC
- VOCs and SVOCs
- Free phase organics (NAPL)
- TSS
- pH
- Metals

3.3.3.3. UV Oxidation System. The majority of the organic treatment is accomplished in the UV Oxidation system. Since the UV lamps have to be adjusted to the flow and concentration of contaminants, the process control of this system is critical to ensure successful operation and compliance with discharge standards.

The following control parameters will be used during the UV Oxidation system start up:

- Flow rate through this system, which determines the retention time.
- Organic loading, which determines the chemical dosage and UV intensity.
- Intensity of UV lamps, which determine destruction efficiency of organic contaminants.
- Hardness of the influent water, which determines the scaling potential in the system and consequently, the system efficiency.
- pH and alkalinity, which determine the acid dosage.

Analytical tests required on the UV Oxidation system effluent include:

- General organics - BOD, COD, TOC
- VOCs and SVOCs
- NAPL
- TSS
- pH and alkalinity

The sampling and analysis plan for the UV Oxidation system will compare influent and effluent quality, and determine the organic loading on the UV Oxidation system, the process efficiency (organics removal), the chemical consumption, and will characterize the primary effluent for determining the secondary treatment scheme.

3.3.3.4. Chemical Precipitation Unit. This system will be primary treatment for metals removal from the ground water. The nature of the Chemical Precipitation Unit treatment to precipitate the metals at a high pH (about 10.0) will require pH monitoring at the flash mix/floc tank and also at the pH Adjustment Tank, where the pH of the water will be readjusted down to the neutral range.

In terms of sampling and analytical, TSS analysis at the influent and effluent sampling points will be performed to determine process efficiency and also effluent quality.

3.3.3.5. Secondary Treatment. In the Upflow Sand Filter, process efficiency is determined by suspended solids removal. Therefore, influent and effluent testing for TSS will be performed at the influent and effluent points of the system.

At the pH Adjustment tank, chemicals will be added to adjust the pH of treated water to between 6 and 9 s.u.. pH adjustment will be conducted in the auto mode.

At the GAC Contactors, the key parameters are total toxic organics (TTOs). The GAC Contactors commonly operate in series in a lead/lag mode. Influent samples and two effluent samples (at the discharge of each contactor) will be taken to determine the process efficiency and also to identify the breakthrough point for the lead unit. At this point, when treatment efficiency has significantly deteriorated, the GAC in this unit will be replaced with fresh carbon and the units will be switched over, so that the better conditioned unit operates as the lag unit.

3.3.3.6. Effluent Sump and Weir Box. Treated effluent from the GAC Contactors will flow in to the effluent sump, over the V-notch weir, and to the discharge point. Discharge flow rate will be measured based on the head above the weir. Samples will be collected using the composite sampler and analyzed for discharge parameters.

3.3.3.7 Effluent Discharge. Effluent will be initially discharged to temporary, 10,00-gallon storage tanks during the startup period. Effluent not meeting the discharge standards will be recycled back to the influent equalization tank for further treatment as required. Effluent that meets the treatment standards will be discharged from the temporary storage tanks to the wetlands.

3.4 PERFORMANCE TEST PROGRAM

Once the PGCS system is acclimated at the initial flow conditions, a performance test program will be conducted. The purpose of this test is to verify the ability of the PGCS components to successfully treat the ground water at the design condition of 60 gpm.

In order to test the system performance at the design flow conditions, it is necessary to adjust the system operation to 60 gpm. The system will then be operated continuously at 60 gpm for a period of five days. The performance test requirements are presented in Table 3-1.

3.5 PROCESS ADJUSTMENT STAGE

After the Performance Test Program is completed, the system will be readjusted back to the actual flow conditions. It is not certain what the flow condition will be at that time and whether the process adjustments will be minor or significant. The operational data for the performance test stages in the facility start up will be used as a basis for the process adjustment plan, determining the optimum operating parameters for achieving the performance goals for effluent discharge to the wetlands, under current flow conditions.

TABLE 3-1
PERFORMANCE TESTING REQUIREMENTS

System	Performance Requirements	Comments
Extraction Trench		
Water Table Depression	1 foot	Below ambient level based on level measured in reference piezometers.
Phase Separator		
Specific Gravity Difference	0.1	
Maximum Effluent Oil	100 mg/l	
UV Oxidation System		
Minimum Organics Removal	99 %	Priority Pollutants
Chemical Precipitation Unit		
Maximum Effluent TSS Conc.	30 mg/l	
Upflow Sand Filter		
Maximum Effluent TSS	5 mg/l	
Maximum Effluent (metals)	1 mg/l iron	
GAC Contactors		
Minimum Organics Removal	99 %	Priority Pollutants
Filter Press		
Minimum Cake Solids Content	25 %	
Maximum Polymer Dose (per ton of dry solids)	2 lbs	
Maximum Filtration Cycle	6 hrs	

4.0 PRETREATMENT FACILITIES

4.0.1. Introduction

The pretreatment stage prepares the various groundwater streams from the site for the down stream main treatment processes. The pretreatment system incorporates removal of oil, grease and free phase organic constituents in the high-strength groundwater from OFCA and SBP, prior to blending with low strength groundwater from other source areas. Some of the heavier suspended solids are also removed. Geoprobe samples from both areas have been shown to contain significant amounts of free phase material, and in bench scale testing, this material has been shown to be readily separable. The low-strength groundwater from the PGCS and ONCA also has the potential for having trace amounts of free phase material, and therefore, the necessary piping is provided to route this stream through the phase separator as well.

Effluent from the Phase Separator is combined with groundwater from the PGCS and ONCA sources in the Pretreatment Equalization Tank, from where it is pumped to the main treatment processes. The NAPL accumulates at the oil trough in the separator and is pumped periodically to the NAPL Storage Tank. Solids that settle in the Phase Separator are pumped to a Sludge Storage/Thickening Tank.

4.1 PROCESS COMPONENTS

The pretreatment process is composed of a Phase Separator, Pretreatment Equalization Tank, NAPL Storage Tank, Sludge Storage/Thickening Tank, and Sludge Transfer Pumps. Refer to Appendix I for the Process and Instrumentation drawings and the mechanical layout of the PGCS facility.

4.1.1. Phase Separator

Separation of undesirable material will be accomplished using a gravity separator with coalescing plates to aid in phase separation. The recovered NAPL material will be skimmed from the top of the tank and will flow by gravity to a NAPL storage tank located below the separation unit. Solids which settle out in the separator will be pumped to a sludge storage tank for thickening prior to either off-site disposal or dewatering in a filter press. The Phase Separator design criteria is listed below.

Parameter	Design Criteria
Number	1 initial, 1 future
Type	Coalescing Plate, stainless steel
Dimensions	4.4'W x 6.7'L x 4'H
Capacity (max.)	20 gpm (each)
Capacity (avg.)	13 gpm (each)
Hydraulic Retention. Time	40 min. @ 20 gpm
Overflow Rate (max.)	1000 gpd/sf
Specific Gravity Difference	0.1
Particle Size Cutoff	25 µM

4.1.2. NAPL Storage Tank

The NAPL separated from the extracted groundwater by the Phase Separator overflows by gravity to the NAPL Storage Tank, prior to transportation to an off-site reclaimer. The NAPL Storage Tank design criteria is presented below.

Parameter	Design Criteria
Number	1
Type	Stainless Steel, cylindrical
Capacity	6,500 gal.
Diameter	10 feet
Side Wall Depth	12 feet

4.1.3. Sludge Transfer Pump

Solids which settle out in the Phase Separator are pumped periodically to the Sludge Storage/Thickening Tank. The Phase Separator is provided with an air diaphragm pump for transferring the sludge collected in the hopper to the Sludge Storage/Thickening Tank. Pump operation is automatic based on the sludge level. The Sludge Transfer Pump design criteria is presented below.

Parameter	Design Criteria
Number	1 initial, 1 future
Type	Air Diaphragm
Max. Flow Rate	125 gpm
Material of Construction	Kynar Body, Viton/Teflon Diaphragm, Teflon Ball Valves

4.1.4. Pretreatment Equalization Tank

To provide sufficient blending and equalization of the influent streams, 50 minutes of equalization capacity at a flow of 60 gpm will be provided in the Pretreatment Equalization Tank. The equalization tank will receive low-strength groundwater directly from the PGCS and ONCA, and effluent from the Phase Separator. The tank is supplied with a mixer to blend the two groundwater and functions as a wetwell for the influent feed pumps for the main treatment processes. The Pretreatment Equalization Tank design criteria is presented below.

Parameter	Design Criteria
Number	1
Type	Stainless Steel, cylindrical
Capacity	3,000 gal.
Diameter	8 feet
Side Wall Depth	9 feet

4.1.5. Sludge Storage/Thickening Tank

The Sludge Storage/Thickening Tank is equipped with multiple ports allowing supernatant withdrawal directly into the Backwash Sump. Sludge will be pumped periodically from the tank to the Filter Press for dewatering. The Sludge Storage/Thickening Tank design criteria is provided below.

Parameter	Design Criteria
Number	1 future
Type	Stainless Steel, conical bottom
Capacity	6,500 gal.
Diameter	9 feet, conical bottom
Side Wall Depth	19 feet

4.1.6. Storage Tank Transfer Pump

Solids collected in the Storage Tank are pumped periodically to the Filter Press for dewatering. The Storage Tank is provided with two air diaphragm pumps for transferring the sludge to the Filter Press. Pump operation is automatic based on the sludge level. The Storage Tank Transfer Pump design criteria is presented below.

Parameter	Design Criteria
Number	1 future
Type	Air Diaphragm
Max. Flow Rate	125 gpm
Material of Construction	Kynar Body, Viton/Teflon Diaphragm, Teflon Ball Valves

4.2 SYSTEM OPERATION AND CONTROL

4.2.1. Phase Separation

The primary function of the phase separation system is to remove free-phase organic material and suspended solids in the groundwater from the high-strength source areas (OFCA and SBP). All liquids from these areas are combined and conveyed to the phase separator which is located on an elevated platform in the treatment systems building. Groundwater from extraction pumps flows directly into the separator. Effluent from the separator flows by gravity to an equalization tank before being pumped to downstream treatment processes. The NAPL collected by the separator flows by gravity to an NAPL storage tank located directly below the phase separator platform. There will be no control of either effluent or NAPL flow from the separator other than manual open/close valves on the influent and effluent lines. The valves will normally be in the open position to allow free flow of both liquids from the separator. Effluent weir will be set manually during the start-up phase.

Solids that settle out in the separator will collect in a hopper and will be pumped on an intermittent basis to a Sludge Storage/Thickening Tank. The sludge pump will operate off of a sludge interface level switch and will have a timer located inside the Phase Separator. The tank will be equipped with multiple decant ports which will discharge to a pipeline carrying waste liquids to the filtrate/decant/backwash sump. The decant discharge line will be provided with a sight glass so that the plant operator can assess the quality of the liquid withdrawn. The operator will visually inspect the quality of the supernatant before sludge is transferred to the filter press. If needed, sludge will stored in the Sludge Storage/Thickening Tank for an extended period to improve the quality.

Sludge from the storage tank will be either dewatered using a filter press or it will be removed periodically by a truck and transported off-site for disposal. Foul air will be collected from the separator, pretreatment equalization tank, oil storage tank and sludge storage tank and vented through a vapor phase carbon adsorption column. The foul air treatment system is described in Section 6.0 of this document.

4.3 OPERATING PROCEDURES

This section summarizes the operating procedures for the pretreatment facilities. The detailed operating procedures are described in the vendor literature which will be included in Appendix II of this document. Appendix II will be updated as more information is available. These include step-by-step procedures during start up, routine operations, shut downs, and abnormal modes for each pretreatment process component.

Emergency circumstances frequently do not allow time to read a plan. Therefore, it is imperative that the operator is trained and be thoroughly familiar with all applicable safety requirements. Occupational safety depends on people knowing what to do and how to do the job correctly.

4.3.1. Start Up

At the initial start up, the Phase Separator will be filled with water stored during the system water test program (see Section 3.2). Clean water, preferably from a fire hydrant or any other convenient source, will be used for this water test.

- Verify that all gratings, safety barricades are in proper place. Ensure that equipment guards are in place and securely assembled.

- Check operation of all valves. They should work smoothly and seat in the closed position.

- Verify the position of all valves for initial start up per the equipment manufacturer's recommendation.

- Open all vent valves to the process air collection system.

- Perform additional start-up checks per the equipment manufacturer's recommendation.

- Turn on the extraction pump at the PGCS trench to allow for pumping of groundwater to the treatment facility.

- Set pump operation to auto mode.

- Once water begins flowing through the Phase Separator, adjust the treated water overflow weir to the desired level.

4.3.2. Normal Operations

Normal operations include performing process checks, conducting the treatment system performance evaluations, conducting equipment inspections, and performing general house keeping tasks.

- Complete the operator checklist and record all data required on the operation logs.

- Conduct equipment inspection, process control, and routine maintenance per the equipment manufacturer's recommendations.

- Conduct equipment decontamination and house keeping as required.

- Refer to the Performance Standard Verification Plan (PSVP) for explanation of process observations, monitoring and laboratory analyses, and performance parameter calculations.

4.3.3. Shut-Down Procedure

- If shut-down is for an extended period of time, shut-down the extraction pumps and close all influent and effluent valves.

- Remove NAPL and sludge from storage tanks.

- Open electrical circuit breakers at panel to discontinue electrical power to the air compressor unit motor and the pretreatment process components.

- Perform general house keeping tasks.

- Note that start-up procedures will have to be repeated when system operation is desired after an extended shut-down.

4.4 TROUBLE SHOOTING

The list below is not intended to be an inclusive list, but is intended to provide general guidelines and recommendations of the things to look for when trouble-shooting. Refer to the equipment manufacturer's literature (Appendix II) for equipment repairs and maintenance. Note that all trouble-shooting will be conducted by a trained and competent personnel who are familiar with equipment details.

4.4.1. Reduced Effluent Quality

- If flow through the system changes significantly, adjust the effluent weir.

- Check the level of NAPL over the separator packs. The depth may not be sufficient to allow the NAPL to drain adequately.

- Check depth of solids at the bottom. Perform manual valve operation if required.

- Check the probes for any build up.

4.4.2. Sludge Pump Failure

- If the air diaphragm pumps should fail, check the compressor, solenoids and switches.

- The electrical supply may be broken and should be repaired by an electrician.

- The pumps may need servicing, if so, take the pump out of service and perform maintenance and reinstall as per the manufacturer's recommendation.

4.5 PREVENTIVE MAINTENANCE

The operator performs functions pertaining to equipment maintenance in three general categories:

- House keeping
- Equipment inspection
- Routine preventive maintenance for the pretreatment system components.

General house keeping is described in Section 8.0 of this document. Equipment inspection(s) and routine preventive maintenance will be conducted, as a minimum, per the manufacturer's recommendations and at a frequency specified in the manufacturer's literature.

5.0 MAIN TREATMENT FACILITIES

5.0.1. Introduction

Effluent from the pretreatment facilities flows into the main treatment process. The main treatment process combines physical and chemical processes to provide the desired removal of contaminants (both organic constituents and metals) from the groundwater prior to discharge.

Low-strength groundwater from the PGCS and ONCA will be pumped directly to the main equalization tank where it will be blended with effluent from the high-strength groundwater pretreatment system. The groundwater will then be pumped to a UV oxidation system which will remove dissolved organic contaminants. Effluent from the oxidation system will flow to a metals removal system consisting of precipitation, flocculation and settling. Effluent from metals removal system will flow through a sand filter for removal of residual suspended solids. If needed, the flow will be pumped through granular activated carbon adsorption vessels to remove specific organic compounds prior to discharge. A sludge storage and dewatering system will be provided.

5.1 PROCESS COMPONENTS

The major components of the main treatment process include: Extraction Trench, Main Equalization Tanks, UV Oxidation System, Chemical Precipitation Unit, Sand Filtration, pH Adjustment Tank, Carbon Adsorption Vessels, and the Effluent Sump and Weir Box. Solids dewatering is also included in the main treatment process before transporting the solids for an off-site disposal. Refer to Appendix I for the Process and Instrumentation drawings and the mechanical layout of the PGCS facility.

5.1.1. Extraction Trench

The groundwater extraction trench ("extraction trench") is approximately 1,200 feet long, 12 to 16 feet deep, and 18 inches wide. The trench contains a 6-inch diameter perforated chemical resistant high density polyethylene pipe covered with a filter fabric sock and is backfilled with 3/8 to 1/2 inch gravel to provide a flow path to the extraction drain pipe. The pipe slopes at a rate of 0.005 feet per foot to two 2-foot diameter sumps located as shown on the site plan (Appendix I). The drain pipe elevation varies from approximately 2 feet above the clay layer at the sumps to about 5 feet above the clay layer at the pipeline high points. Groundwater is extracted from the sumps using electrical submersible pumps and is conveyed to the treatment building using a buried, 2-inch, high-density polyethylene (HDPE) pipe.

5.1.2. Main Equalization Tank

To provide sufficient blending and equalization of the influent streams, 80 minutes of equalization capacity at a flow of 60 gpm will be provided in the Main Equalization Tank. The equalization tank will receive low-strength groundwater directly from the PGCS and ONCA, and pretreated effluent from the high-strength groundwater pretreatment system. The tank will be supplied with a mixer to blend the two groundwater and will function as a wetwell for the influent feed pumps for the main treatment processes. The Main Equalization Tank design criteria is presented below.

Parameter	Design Criteria
Number	1
Type	Stainless Steel, cylindrical
Capacity	5,000 gal.
Diameter	8 feet
Side Wall Depth	13.5 feet

5.1.3. UV Oxidation System

The UV oxidation system provides destruction of the organic components in the groundwater by oxidation of the organic carbon to carbon dioxide and innocuous byproducts such as simple dibasic acids. Halogens such as chloro and bromo substituents are converted to salts. The system uses hydrogen peroxide as the main source of oxidizing potential. Both high intensity UV light and reduced iron salts are used as catalysts. The main oxidizing species created by the process are hydroxyl radicals which form from the decomposition of peroxide by the two catalysts. Oxidation of the organic material and reduced iron in the influent stream will be accomplished by injecting sulfuric acid and hydrogen peroxide. The water will then pass through a reactor containing high intensity ultraviolet lamps. The UV light and reduced iron in the water will catalyze the decomposition of the peroxide into hydroxyl radicals which subsequently attack and destroy dissolved organic material. Ferrous sulfate will also be injected if an additional source of iron is needed, however it use on a regular basis is unlikely because of the relatively high reduced iron content of the groundwater at the site. Some decomposition of organic material will also result from the direct effect of UV light and peroxide which are also oxidizing agents, although they are less powerful than hydroxyl radicals. The reduced iron will also be oxidized in the process and will form an insoluble precipitate upon adjustment of the pH following the reaction.

Effluent from the oxidation process will flow to the metals removal system for removal of iron, and other metals. Suspended solids will also be removed in the metals removal system. The oxidation system will be controlled by a programmable logic controller (PLC) provided by the equipment vendor. The PLC will control the chemical feed systems based on flow (peroxide and ferrous sulfate dosing) and pH (acid addition), and will control the UV light intensity based on flow. Peroxide and sulfuric acid and ferrous sulfate will be added using chemical metering pumps to precisely control the dosages. Bulk storage tanks will be provided for 50 percent peroxide solution and 93 percent sulfuric acid. Ferrous sulfate will be fed from 55-gallon drums. The UV Oxidation system design criteria is presented below.

Parameter	Design Criteria
Number	1
Capacity (max.)	70 gpm
Capacity (min.)	10 gpm
Type	30 kW Stainless Steel Reactor

5.1.4. Chemical Precipitation Unit

Oxidized iron, other metals, such as lead, zinc, nickel, copper and chromium, and suspended solids in the effluent from the oxidation system will be removed in a chemical precipitation unit. The unit will consist of a rapid mix tank in which the pH will be raised to the desirable level (approximately 10 s.u.), a flocculation tank, and a plate settler (Lamella clarifier) with an internal sludge thickener. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustments. The acid feed system will utilize the bulk storage tank previously described as part of the oxidation systems. A bulk storage tank will also be provided for 50 percent sodium hydroxide solution. Liquid polymer will be used to aid in coagulation and flocculation of the metal precipitates and suspended solids. The polymer feed system will consist of a metering pump and a polyblend mixing system. Emulsion polymer (approximately 30 percent solution) will be fed from a day tank (55-gallon drum) and will be diluted to approximately one percent by the polyblend system before being fed to the rapid mix tank. Sludge from the settler/thickener unit will be pumped to a sludge storage and thickening tank. Effluent from the settler will flow by gravity to the upflow sand filtration unit. Chemical Precipitation Unit design criteria is presented below.

Parameter	Design Criteria
Chemical Precipitation Unit	
Number	1
Type	Package rapid mix, flocculation, plate settler, sludge thickener with acid, base , and polymer delivery systems
Dimensions	8 feet x 13 feet x 19 feet
Rapid Mix Time @ 60 gpm	2 min.
Flocculation Time @ 60 gpm	20 min.
Plate Settler Loading Rate @ 60 gpm	600 gpd/sf
Sludge/Scum Pump	
Number	1 initial, 1 future
Type	Air Diaphragm
Max. Flow Rate	125 gpm
Material of Construction	Kynar Body, Viton/Teflon Diaphragm, Teflon Ball Valves

5.1.5. Upflow Sand Filter

The residual suspended solids in the metals precipitation unit effluent will be removed using an upflow, continuous backwash sand filter. A continuous backwash filter was chosen over conventional gravity sand filters or pressure sand filters to eliminate the need for a backwash cycle and the associated storage facilities and pumps. Operator attention requirements are also reduced with a continuous backwashing system. Influent to the filter will flow by gravity from the Lamella clarifier. The filter influent will have enough gravity head to pass through the sand bed and into the pH adjustment tank (following the filter) without the need for pumping. Continuous backwash will be provided using an airlift pump, which will pump a small percentage of flow containing the filtered solids from the system. Filter backwash water will flow to the filtrate, decant water and backwash sump prior to being returned to either the phase separator or the main equalization tank. Sand filter design information is provided below.

Parameter	Design Criteria
Number	1
Type	Upflow Continuous Backwash
Media Depth	40 inches
Loading Rate (max.)	5 gpm/sf
Diameter	4 feet

5.1.6. pH Adjustment Tank

The pH of the effluent from the metals removal system and sand filter will be adjusted to between 6 and 9 s.u. for final discharge. pH adjustment will be accomplished in a tank which will be equipped with a mixer, pH probe and a controller. Sulfuric acid and sodium hydroxide feed systems will be provided for pH adjustments. Acid and base will be provided from the bulk storage tanks previously described. The pH adjustment tank will also serve as a wetwell for the effluent pumps which will convey effluent through the GAC contactors or directly to the effluent sump and weir box. The effluent pumps will be sized to pump against the total head associated with GAC system and elevated effluent sump and weir box. The pH Adjustment Tank design information is provided below.

Parameter	Design Criteria
Number	1
Type	Epoxy coated steel, cylindrical
Capacity	3,000 gal.
Diameter	8 feet
Side Wall Depth	9 feet

5.1.7. GAC Contactors

If the final filtered effluent contains specific chemical constituents in concentrations above the allowable discharge goals, the flow will be routed through GAC contactors for additional treatment. Under normal operating conditions, the use of GAC for effluent polishing is not expected to be necessary. The GAC system will function as a backup system to the other treatment processes should upsets, failures or unexpected problems arise with those systems. The GAC system will also be used during startup to ensure compliance with effluent limits. The GAC contactor system will be a vendor supplied package consisting of two contactor units. The system will have the capability to operate in either parallel or series mode depending on the particular treatment needs. Each column will, however, have the hydraulic capacity to pass the maximum flow from the treatment plant. Replacement of the carbon will need to be conducted periodically when the adsorption capacity has been exhausted. Spent carbon will be replaced by the carbon system supplier (in conjunction with the plant operators). Carbon exhaustion will be determined by effluent sampling and analysis, and by operator experience. Flow to, and through, the GAC system will be controlled by manually adjusting the proper valves. The GAC vessel design information is provided below.

Parameter	Design Criteria
Number	4 (2 initial plus 2 future)
Type	Downflow pressure vessels
Diameter	4 feet
Height	7.5 feet
Hydraulic Loading Rate	5 gpm/sf
Carbon content per vessel	1,500 pounds
Carbon Type	8 X 30 React

5.1.8. Effluent Sump and Weir Box

Treated water will flow into the effluent sump and weir box either directly from the pH adjustment tank or from the GAC contactors. The sump will consist of a mixing chamber, baffle wall, stilling chamber, and a V-notch weir. Flow will enter the mixing chamber at which point the pH will be continuously monitored and readjusted if necessary to ensure it is within the desirable range for discharge (6 to 9 s.u.). Acid and base feed systems will be provided for pH adjustments. After pH monitoring and adjustment, the flow will pass through a baffle wall and into the stilling chamber. Flow will pass through the stilling chamber and over a V-notch weir before entering the final discharge pipe. An ultrasonic gauge will continuously measure the water level in the stilling chamber. The ultrasonic gauge will convert the water depth in the stilling chamber to flow rate and provide a local display. The gauge will also be connected to a strip chart recorder for continuous monitoring and recording of discharge flow. A staff gauge will be provided for manually calibrating the ultrasonic flow meter. A flow paced effluent sampler will collect composite samples from the stilling chamber via an effluent sample line. Discharge from the effluent sump and weir box will flow by gravity to the wetlands diffuser system for final discharge. A recycle line will be provided from the effluent sump to the filtrate, decant water, backwash sump so that effluent can be recycled to the head of the plant during startup of the treatment system. The effluent structure design information is provided below.

Parameter	Design Criteria
Number	1
Type	Epoxy coated steel tank
Width	4 feet
Length	8 feet
Side wall depth	5 feet
Volume	1,000 gal.
Weir	30° V-notch; 5.87" (max head), 4.09" (min head)

5.1.9. Sludge Disposal System

The sludge disposal system provides a means to accumulate and concentrate metals sludge and pretreatment system sludge prior to dewatering for off-site disposal. The elements of this system are: a mixed sludge storage and thickening tank, polymer feed system, diatomaceous earth feed system plate and frame filter press and sludge transfer pumps.

Sludge from the metals precipitation system and from the phase separation system will be pumped to sludge storage tanks equipped with a mixers for blending. Sludge will be allowed to settle and thicken in the storage tank prior to dewatering. The sludge storage tanks will be equipped with multiple decant ports for removal of free water. The decant ports will discharge to a pipeline carrying waste liquids to the filtrate, decant water, and backwash sump. The decant discharge line will be provided with a sight glass so that the plant operator can assess the quality of the liquid withdrawn. Thickened sludge from the storage tanks will be pumped to filter press for dewatering. Polymer addition for sludge conditioning will be provided by a metering pump. Liquid emulsion polymer (approximately 30 percent) will be fed directly from 55-gallon drums into the influent to the filter press. Diatomaceous earth will be fed as either precoated or body-feed during sludge dewatering. An inline mixer will be provided for blending. Filter cake from the press will drop into a roll-off dumpster and will be periodically transported off-site for disposal.

Design information on the sludge handling and disposal system is provided below.

Parameter	Design Criteria
Filter Press	
Number	1
Type	Plate and Frame Press
Volume	30 cubic feet
Sludge Transfer Pumps	
Number	2
Type	Air Diaphragm
Max. Flow Rate	125 gpm
Polymer Feed System	
Number	2
Type	Polymer metering pumps
Diatomaceous Earth Feed	
Number	1
Type	Day tank and feed pump

5.1.10. Filtrate, Decant Water, Backwash Sump

A main process sump will be provided to collect reject water from all of the unit processes, and from the floor sumps within the building containment structure. The water collected in the sump will be returned to either the influent line to the phase separator or to the main treatment system equalization tank at the discretion of the plant operator.

5.1.11. Area Sumps

Two floor sumps will be provided in the building containment area to collect spills and washdown water. Any water collected in the sumps will be manually returned to the main process sump using a portable sump pump. A floor sump will also be located beneath the roll-off dumpster to collect drainage from the dewatered sludge and washdown water from the sludge storage pad. This sump will be equipped with a level controlled sump pump which will return water to the main process sump. Design information on the above sumps is provided below.

Parameter	Design Criteria
Filtrate, Decant Water, Backwash Sump	
Number	1
Type	Stainless steel, cylindrical
Volume	1,000 gal
Diameter	5 feet 4 inches
Side wall depth	6 feet 5 inches
Filtrate, Backwash Sump Pumps	
Number	2
Type	Horizontal centrifugal
Rated capacity	30 gpm, each
Area Sump	
Number	1
Type	Stainless steel, cylindrical
Volume	1,000 gal
Diameter	5 feet 4 inches
Side wall depth	6 feet 5 inches
Area Sump Pump	
Number	1
Type	Submersible with internal float
Rated capacity	30 gpm

5.1.12. Wetland Discharge System

Treated groundwater flows by gravity from the effluent weir box in the treatment building to a valve vault where flow is split into three discharge pipes. Each discharge pipe then distributes a portion of the effluent to a different location in the wetlands. At the end of each discharge pipe, a 4-inch diameter by 10-foot long poly vinyl chloride (PVC) diffuser is provided to spread the water such that it does not adversely impact the wetlands. The diffuser system is set in a man-made embankment to protect the pipes from freezing. The system is also self-draining to further reduce the possibility of freezing should the water be shut-off. The embankment is about 5 to 6 feet high at its peak and riprap is located below the diffuser to reduce erosion. Effluent conveyance piping is 4-inch diameter PVC and has a minimum soil cover of 4 feet for freeze protection.

5.2 SYSTEM OPERATION AND CONTROL

The operation of the treatment system will combine automated control of packaged equipment with manual control of flow distribution. The decision to send flow to a specific unit process will be the responsibility of the plant operator. An overall plant monitoring system will be provided on the main control panel located in the electrical and instrumentation room. The main control panel will contain status indicators for the process units and tank level alarms. Motors and individual treatment units will be started from local control panels near each piece of equipment. The control of each process is described below in this section.

5.2.1. Extraction Trench

5.2.1.1. Water Level Measurements. The operation of the extraction trench is based on achieving a water table drawdown one foot lower than the ambient level at the trench. Water level information in the trench, near the trench and at a reference location far from the trench is necessary to allow assessment of the drawdown in the trench. Water levels should be measured in the trench piezometers, in nearby piezometers (those that are installed 25 feet up and down gradient from the trench, in existing piezometers near the trench [P-23 through P-27]) and in reference piezometers far upgradient from the trench. Upgradient piezometers include P-31, P-40 and P-41. The water levels in all piezometers will vary over time depending on the weather conditions and amount of precipitation at the site. Therefore, the target drawdown in the trench should be adjusted based on the fluctuations in water level in the reference piezometers. These adjustments will require periodic measurements of the water level in the trench and in the reference piezometers.

5.2.1.2. Extraction Trench. After the initial startup of the trench, the water level switches in each trench sump should be periodically adjusted so that the water level in the trench remains at least one foot below ambient conditions. The flow rate from each pump should also be adjusted periodically so that the extraction rate (adjusted for downtime of the pumps) from the trench matches the trench inflow.

5.2.2. Main Equalization Tank

The equalization tank will receive low-strength groundwater directly from the PGCS and ONCA, and effluent from the high-strength groundwater pretreatment system. The tank will be supplied with a mixer to blend the two groundwater. The mixer will operate continuously except when the liquid level in the tank drops to a level of about 4 feet from the bottom of the tank at which point the mixer will shutoff automatically. The equalization tank will serve as a wetwell for the influent pump station which will feed downstream treatment processes. Pump station control will be based on the liquid level in the equalization tank. There will be four level switches in the tank: low level; low operating level; high operating level; and high-high level. Once the liquid level in the tank reaches the high operating level switch (about 8 feet deep), one of the three influent pumps will start. If the single pump cannot keep up with the flow entering the tank a second pump will start. If the liquid level in the tank continues to rise above the high level switch and trips the high-high level alarm, a signal will be sent to stop the well pumps and extraction pumps in the field and all other liquid treatment processes within the plant. Level indicators and high level alarms will be provided at the main control panel in the electrical and instrumentation control room.

5.2.3. UV Oxidation System

The system will operate under the control of a programmable logic controller (PLC) which will be provided by the equipment vendor. The PLC will control the chemical feed systems (peroxide and ferrous sulfate dosing) and UV light intensity based on the measured flow rate from the influent pump station. The system will also control the addition of acid based on the measured pH in the influent. Refer to Section 4.2.2 for further information on the UV Oxidation system control.

5.2.4. Chemical Precipitation Unit

Effluent from the UV oxidation system will be routed through the metals removal system by manually adjusting the appropriate valves. The operators will open and close the necessary valves and activate the local control panel for the metals removal system. The local control panel will start the various mixers and will energize the controllers for the chemical metering pumps and sludge pumps. The mixers will operate continuously while the system is on-line. The chemical metering pumps for acid and base will operate off of a pH-based control loop. The polymer feed system will operate off the measured flow rate through the UV oxidation system. All metering pumps will have a manually adjustable stroke length to control dosage. The sludge pumps will operate off of a timer.

5.2.5. Upflow Sand Filter

Flow through the sand filter will be controlled by manually adjusting the valves on the filter influent line and the filter bypass line. The airlift pump which controls filter backwash will be on continuously when the filter is in operation. Air to the pump will be controlled by a solenoid valve that will allow air supply to the filter when the influent pumps to the UV oxidation system and metals removal system are running.

5.2.6. pH Adjustment

The pH adjustment tank will be supplied with a mixer to blend the pH adjustment chemicals with the filtered effluent. The mixer will operate continuously except when the liquid level in the tank drops to a level of about 3 feet at which point the mixer will shutoff automatically. The equalization tank will serve as a wetwell for the effluent pump station. Pump station control will be based on liquid level in the equalization tank. There will be four level switches in the tank: low level; low operating level; high operating level; and high-high level. Once the liquid level in the tank reaches the high level switch (about 6 feet, deep), one of the three influent pumps will start. If the single pump cannot keep up with the flow entering the tank a second pump will start. If the liquid level in the tank continues to rise above the high level switch and trips the high-high level alarm a signal will be sent to stop the well pumps and extraction pumps in the field and all other liquid treatment systems in the plant. Level indicators and high level alarms will be provided at the main control panel in the electrical and instrumentation control room.

5.2.7. GAC Contactors

All operations of the GAC system will be manually controlled by the operators.

5.2.8. Effluent Sump and Weir Box

Flow will enter the mixing chamber at which point the pH will be continuously monitored and adjusted to ensure it is within the desirable range for discharge (6 to 9 s.u.). The mixer will be manually controlled with an on-off switch. Acid and base feed systems will be provided for pH adjustments. The chemical metering pumps for acid and base will operate off of a pH based control loop. An ultrasonic gauge will continuously measure the water level in the stilling chamber. The level will be converted to effluent flow rate which will be continuously recorded. A flow paced effluent sampler will collect either composite or discrete samples from the stilling chamber via an effluent sample line.

5.2.9. Sludge Handling System

All operations of the sludge handling system will be started manually. Valves for decanting supernatant from the sludge storage tanks will be controlled manually. The filter press operation will be initiated manually and the sludge pumps started from an automatic sequence relay controlled by the filter press system. Once initiated, the filter press cycle will be controlled by a vender supplied control system. Polymer addition will be controlled using a metering pump which will be paced inversely based on inlet pressure to the filter press. Filtrate will return by gravity to the filtrate, decant water and backwash sump, and will be pumped back to either the phase separator or the equalization tank.

5.2.10. Filtrate, Decant Water, Backwash Sump

Pump station control will be based on liquid level in the sump. There will be three level switches in the sump tank: low level; high level; and high-high level. Once the liquid level in the tank reaches the high level switch (about 4 feet, deep), one of the two sump pumps will come on. If the single pump cannot keep up with the flow entering the tank a second pump will start. If the liquid level in the tank continues to rise to the high-high level an alarm will sound. Level indicators and high level alarms will be provided at the main control panel in the electrical and instrumentation control room.

5.2.11. Area Sumps

The two sumps located in the floor of the main building containment area will be pumped out manually by the operators. Pumping of the sump located under the sludge dumpster will be controlled based on level.

5.2.12. Wetlands Discharge System

The flow to the wetland diffuser system is manually controlled by adjusting the proper control valves located in the diffuser system valve vault. The system is designed to split the flow equally between the three diffusers if all of the valves are in the fully open position. Flow to any of the diffusers can be adjusted or turned off by adjusting the appropriate valve on the diffuser feed line.

5.3 OPERATING PROCEDURES

This section summarizes the operating procedures for the pretreatment facilities. The detailed operating procedures are described in the vendor literature included in Appendix II of this document. Appendix II will be updated as more information is available. These include step-by-step procedures during start up, routine operations, shut downs, and abnormal modes for each pretreatment process component.

Emergency circumstances frequently do not allow time to read a plan. Therefore, it is imperative that the operator is trained and be thoroughly familiar with all applicable safety requirements. Occupational safety depends on people knowing what to do and how to do the job correctly.

5.3.1 Start Up

5.3.1.1. Groundwater Extraction Pumps.

- Check pump lubrication, alignment and rotation.
- Open all valves in the suction and discharge lines.
- Set the HOA switch for pumps at the MCC to AUTO.
- Set electrical connections to ON.

- Verify pump operation corresponds to the level switch sequence setting.
- Verify auto shutoff at low level in tank.
- Check for unusual noises, vibrations, overheating, and leakage.
- Check flow meter and totalizer on the PLC.

5.3.1.2. Main Equalization Tank.

- Open process air vent valve.
- Open the primary influent fill valve from the Pretreatment Equalization Tank.
- Close any bypass valves and recirculation lines.
- As the Main Equalization Tank is filling, verify that level gauge indicates the correct fluid level.
- Turn the mixer ON. Adjust the mixer speed to the desired setting.

5.3.1.3. UV Oxidation System. The steps presented here provide an outline of the start-up procedure for the UV Oxidation System. Refer to the manufacturer's information for a detailed start up (Appendix II). The operator should be familiar with the step-by-step procedure for the UV Oxidation System start up prior to placing the system into operation.

- Close any bypass valves and recirculation lines.
- Verify that the peroxide, acid, and catalyst feed system is in the Auto position. Open the required suction and discharge valves at the chemical metering pump. Adjust the chemical pumps to the desired feed rate.
- Close circuit breaker at the MCC to supply power to the PLC and the treatment unit. Follow manufacturer's instructions for start up procedures.
- Open the primary influent fill valve from the Main Equalization Tank.

- Ensure that the inline mixer upstream of the oxidation unit is in operation.

- While in operation, conduct the manufacture recommended monitoring during start up.

5.3.1.4. Influent Pumps. Repeat the sequence described in Section 5.3.1.1.

5.3.1.5. Chemical Precipitation Unit. During the start up, the Lamella thickener unit will be filled with water. Water from the system water testing program shall be used.

- Open influent valve to the Flash Mix/Floc Tank.

- Verify that the caustic, acid and polymer feed systems are in the Auto position. Open the required suction and discharge valves at the chemical metering pump. Adjust the chemical pumps to the desired feed rate.

- Confirm that plant air supply is available at the sludge pumps.

- Chemical Precipitation Unit operates via its individual PLC. Follow the manufacturer's instruction for start up of the PLC and the various components, including the mixers and pumps.

5.3.1.6. Upflow Sand Filter.

- Confirm all valves on filter influent and effluent lines are set according to manufacturer's instructions.

- Confirm all valves on filter skid are set according to manufacturer's instructions.

- Turn the panel power ON.

- Follow the manufacturer's instructions for start up of the filter unit.

- Perform system monitoring according to the manufacturer's instructions.

5.3.1.7. pH Adjustment Tank.

- Open the primary influent fill valve from the Pretreatment Equalization Tank.

- Verify that the caustic and acid feed system is in the Auto position. Open the required suction and discharge valves at the chemical metering pump. Adjust the chemical pumps to the desired feed rate.

- Close any bypass valves and recirculation lines.

- As the Main Equalization Tank is filling, verify that level gauge indicates the correct fluid level.

- Turn the mixer ON. Adjust the mixer speed to the desired setting.

5.3.1.8. Effluent Pumps. Repeat the sequence described in Section 5.3.1.1.

5.3.1.9. GAC Contactors. The following procedures will be performed at start up:

- Determine the lead and lag units for operation in series.
- Open the GAC effluent valves for lead/lag operation.
- Close GAC backwash valves.
- Open the GAC influent valves for lead/lag operation.
- Open the discharge valves from GAC units to receive effluent.
- While in operation, perform system monitoring per manufacturer's instructions.

5.3.1.10. Effluent Sump and Weir Box.

- Verify that the caustic and acid feed system is in the Auto position. Open the required suction and discharge valves at the chemical metering pump. Adjust the chemical pumps to the desired feed rate.

- Turn the mixer ON.

- As the weir starts to fill, observe liquid level over the V-notch. Perform calibrations.

5.3.1.11. Sludge Handling System. The steps presented here provide an outline of the start-up procedure for the sludge handling system, including the filter press, sludge transfer pumps, chemical feed, and the support systems. Refer to the manufacturer's information for a detailed start up.

- Verify that adequate polymer and diatomaceous earth solution is available. Prepare new stock solution as required.

- Verify that the polymer and diatomaceous earth solution feed systems are in the Auto position. Open the required suction and discharge valves at the chemical metering pump. Adjust the chemical pumps to the desired feed rate.

- Confirm that the plant air supply to the air diaphragm pumps and the press is ON, and pressure setting at the desired value.

- Verify that adequate sludge is available in the Sludge Storage/Thickening Tank. Open sludge outlet valve.

- Follow manufacturer's instructions for actual start up of the sludge handling system.

5.3.2. Normal Operations

Once is system is fully on line and operating at the desired flow rate, the treatment facilities will be operate by themselves based on the vendor PLCs and other instrumentation. The system design incorporated complete automation of the treatment systems; operator attention has been minimized. However, the operator has to conduct routine and preventive maintenance to avoid break downs in the treatment system; perform process monitoring as specified in this document, other project-specific documents or the manufacturer's information; and complete operational logs for record keeping and documentation.

5.3.2.1. Start Groundwater Extraction Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.2.2. Main Equalization Tank.

- Check the tank and piping for leaks.
- Check level indicators for proper operation.
- Check mixer for lubrication, noise, vibration, alignment and shaft motion.

5.3.2.3. UV Oxidation System.

- Check the PLC for AUTO operations.
- Check and maintain UV lamps. Replace UV lamps if required. Follow manufacturer's instructions for UV lamp replacement.
- Verify that chemical solutions are available. If needed, prepare fresh stock.
- Verify that the chemical feed pumps are in AUTO position.
- Verify calibration of pH probe.
- Check the mixer for proper operations.
- Perform process monitoring as specified.

5.3.2.4. Influent Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.2.5. Chemical Precipitation Unit.

- Inspect the overall system for leaks and general integrity.
- Verify that the PLC is operating in AUTO mode.
- Verify operation of all pumps, mixers and pH probes.
- Perform process monitoring as specified.

5.3.2.6. Upflow Sand Filter.

- Verify that the backwash selection is in the AUTO position.
- Verify that the backwash pump is in the AUTO position.
- Verify that the air scour blower is in the AUTO position.
- Check the effluent flow rate against the influent.
- Perform process monitoring as specified.

5.3.2.7. pH Adjustment Tank.

- Check the tank and piping for leaks.
- Check level indicators for proper operation.
- Verify that chemical solutions are available.
- Verify that the chemical feed pumps are in AUTO position.
- Check mixer for lubrication, noise, vibration, alignment and shaft motion.
- Verify operation and calibration of pH probe.

5.3.2.8. Effluent Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.2.9. GAC Contactors.

- Visually inspect inlet, discharge and backwash piping for damage.

- Identify the lead and lag contactor units during current operation.

- Verify that all valves are set as described in the start-up procedures.

- Verify that the pressure gauges at each unit do not exceed the backwash setting. If the pressure through one contactor exceeds setting, perform backwash procedures as specified by the manufacturer.

- Perform routine process monitoring procedures as specified. If the lead unit shows poor performance, perform GAC replacement per manufacturer's instructions.

5.3.2.10. Effluent Sump and Weir Box.

- Verify that adequate chemical solutions are available.

- Verify that the chemical feed pumps are in AUTO position.

- Check mixer for lubrication, noise, vibration, alignment and shaft motion.

- Collect samples for on-site or laboratory analyses as specified frequency.

- Calibrate pH probe and flow gauge.

- Monitor pH and flow at the control panel.

- If effluent does not meet regulatory requirements, transfer off-spec effluent to the Main Equalization Tank. Ensure that the inlet valves to the Main Equalization Tank are open before transferring the off-spec effluent.

- Prepare operations log and other documents per the regulatory requirements.

5.3.2.11. Sludge Handling System.

- Clean equipment and general area.
- Confirm that level indicators in sludge storage tanks are calibrated.
- Perform maintenance on the sludge pumps.

- Verify that chemical solutions are available. If needed, prepare fresh stock.
- Verify that the chemical feed pumps are in AUTO position.
- Check mixer for lubrication, noise, vibration, alignment and shaft motion.
- Perform dewatering procedures as discussed in manufacturer's specification.
- Perform process monitoring procedures as specified.
- Coordinate sludge transport to off-site disposal facility.

5.3.3. Shut-Down Procedure

5.3.3.1 Pretreatment Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.3.2. Main Equalization Tank.

- Close fill valves to the tank.
- Shut off the chemical feed system and turn mixer knob to OFF position.

5.3.3.3. UV Oxidation System.

- Close influent valve to the oxidation system.
- Shut off the chemical feed system and turn mixer to OFF position.
- Follow manufacturer's instructions for the Oxidation unit shut off.

5.3.3.4. Influent Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.3.5. Chemical Precipitation Unit.

- Close influent valve to the Flash Mix/Floc Tank.
- Shut off the chemical feed system and turn mixer knob to OFF position.
- Check the sludge bin; pump to Sludge Storage Tank if necessary.

- Leave water in the Lamella unit.

5.3.3.6. Upflow Sand Filter.

- Set the backwash pump to the OFF position.
- Close influent and effluent valves.

5.3.3.7. pH Adjustment Tank.

- Close fill valves to the tank.
- Shut off the chemical feed system and turn mixer knob to OFF position.

5.3.3.8. Effluent Pumps.

- Check the pumps for leaks, normal noise, vibration, alignment and lubrication.
- Check motor for operating temperature and shaft motion.

5.3.3.9. GAC Contactors.

- For normal shut down of one GAC unit, close inlet and discharge valves on the GAC unit taken off service and verify that flow-through the off service unit has completely ceased (by observing the pressure gauge).

- For the GAC system shut down, close all inlet and discharge valves on both units; however, keep contactors full of water to prevent corrosion.

- For replacement of spent carbon, follow the procedures for shut down of one GAC unit. The follow manufacturer's instructions for carbon replacement.

5.3.3.10. Effluent Sump and Weir Box.

- Close inlet valve to the Effluent Sump.
- Turn OFF the mixer at the local panel and at the MCC.
- Shut OFF the chemical feed pumps to storage tanks and filter press.

5.3.3.11. Sludge Handling System.

- Turn off sludge transfer pump(s) to the Sludge Storage Tank.
- Close inlet valves to the storage tank.
- Dewater contents of the tank and close the tank outlet valve.
- Accelerated sludge handling may be required prior to an extended shut down.
- Turn OFF the mixer at the local panel and at the MCC.
- Shut OFF the chemical feed pumps to storage tanks and filter press.
- Follow manufacturer's instructions for the filter press shut off.
- Change the position of all related valves per manufacturer's instructions.

5.4 TROUBLE SHOOTING

Refer to the equipment manufacturer's literature (Appendix II) for equipment repairs and maintenance. Note that all trouble-shooting will be conducted by a trained and competent personnel who is familiar with equipment details.

5.5 PREVENTIVE MAINTENANCE

The operator performs functions pertaining to equipment maintenance in three general categories:

- House keeping
- Equipment inspection
- Routine preventive maintenance for the pretreatment system components.

General house keeping is described in Section 8.0 of this document. Equipment inspection(s) and routine preventive maintenance will be conducted, as a minimum, per the manufacturer's recommendations and at a frequency specified in the manufacturer's literature.

6.0 FACILITY SUPPORT SYSTEMS

6.1 INTRODUCTION

The pretreatment and the main treatment processes at the PGCS treatment facility require support systems as part of the treatment process. The design of the treatment facility incorporates the required support systems to provide a complete and functional groundwater treatment system. The support systems provided with the PGCS treatment facility include:

- Air Collection System
- Air Treatment System
- Compressed Air System
- Facility Water
- Chemical Feed System.

This section provides a description and operational procedures for the support systems.

6.2 PROCESS COMPONENTS

6.2.1. Air Collection System

Process air will be collected from treatment units which have a potential to emit air containing contaminants by covering these units and connecting them to an air collection system. The units connected to the air system at the ACS site are the following:

- Phase Separator
- NAPL Storage Tank
- Sludge Storage/Thickening Tank
- Pretreatment Equalization Tank
- Main Equalization Tank
- Filtrate, Decant Water, Backwash Sump.

The volatile organics in the influent groundwater will be destroyed in the main advanced oxidation system, and therefore, downstream processes such as such as metals removal, sand filtration, pH adjustment and GAC adsorption will not be vented and will be open to the building atmosphere. The filter press will be vented to the outside and the roll-off dumpster will be located in a separate enclosed area which will also be vented to the outside. Vents from all of the tanks needing venting will be connected to a vapor phase carbon bed prior to venting to the atmosphere.

A 2-inch stainless steel line will collect process air from each of the process units listed above to the main process air header. Each air line is equipped with a 2-inch backflow prevention valve.

6.2.2. Air Treatment System

The main air line will be connected to a vapor-phase activated carbon column. Process air will be treated to discharge standards commensurate with the state and local guidelines. The vapor-phase GAC unit will be a vendor supplied package with no instrumentation or controls beside manual valve operation. Replacement of the carbon will need to be conducted periodically when the adsorption capacity has been exhausted. Spent carbon will be replaced by the carbon system supplier (in conjunction with the plant operators). Carbon exhaustion will be determined by effluent sampling and analysis, and by operator experience. Design information for the vapor-phase GAC is presented below.

Parameter	Design Criteria
Number	1
Air Flowrate (avg.)	6 cfm
Vessel Type	55-gallon canister
Carbon Type	8 x 30 React

6.2.3. Compressed Air System

Compresses air will be required for operation of the air diaphragm pumps, filter press, sand filter backwash, wiper drive for the UV oxidation system, and for plant instrumentation. Two air compressors will be included as part of the PGCS treatment facility design. The air compressors will be complete with a blower, compressor system, receiving tanks, gauges, air distribution and control systems, and instrumentation. The air compressor units will be provided to produce the required air capacity to allow simultaneous operation of the air-controlled/operated systems at the PGCS. Design information on the air compressors is provided below.

Parameter	Design Criteria
Compressor	
Number	2
Type	Piston
Capacity	100 scfm
Discharge Pressure	125 psi
Air Receiver	
Type	Welded steel
Number	3
Capacity	240 gallons (each)

6.2.4. Facility Water

Potable, fire and service water for the PGCS treatment facility will be provided through a City line extending to the facility.

6.2.5. Chemical Feed System

Chemical addition will be required to the several treatment processes to maintain pH in the desired range and/or to enhance solids settling and separation. Chemical injection will be conducted at the following process units:

- UV Oxidation System - acid, hydrogen peroxide, and Enox catalyst addition
- Chemical Precipitation Unit - acid, caustic, and polymer addition
- pH Adjustment Tank - acid and caustic addition
- Effluent Sump - acid and caustic addition
- Filter Press - polymer and diatomaceous earth addition.

The chemical addition system includes the following components:

- Sulfuric acid storage tank
- Sodium hydroxide storage tank

- Hydrogen peroxide storage tank
- Polymer storage and day tanks
- Polymer blending system
- Diatomaceous earth storage and day tanks
- Chemical metering pumps
- Instrumentation and control loops.

Parameter	Design Criteria
Sulfuric Acid Storage Tank	
Type	High density polyethylene (HDPE)
Capacity	2,500 gallons
Diameter	8 feet
Height	8 feet
Sodium Hydroxide Storage Tank	
Type	HDPE
Capacity	2,500 gallons
Diameter	8 feet
Height	8 feet
Hydrogen Peroxide Storage Tank	
Type	Aluminum
Capacity	7,000 gallons
Diameter	8 feet
Length	15 feet
Polymer	
Type	55-gallon drum
Feed Form	30 percent solution from 55-gallon day tank
Diatomaceous Earth	
Type	HDPE
Feed Form	Slurry from a day tank
Chemical Metering Pumps	
Type	Diaphragm
Number	13
Capacity	3 gph
Output Head	90 psig

6.3 SYSTEM OPERATION AND CONTROL

6.3.1. Air Collection System

The air system collection system will be a passive system, therefore no control mechanisms will be necessary.

6.3.2. Air Treatment System

All operations of the vapor phase GAC unit will be manually controlled by the operators.

6.3.3. Compressed Air System

The compressed air system will be controlled through the MCC, which provides an HOA switch and an Air Compressor Sequence control. Locally, each unit will have an ON/OFF switch.

The compressed air system will be set on AUTO during plant operation. When the air receiver tank(s) holds its maximum set pressure, the air compressor unit will shut down and when the demand rises for additional air, the MCC will either bring both compressors on-line at the same time or alternate operation to the idle compressor.

6.3.4. Facility Water

The operation of the service water will be manually controlled by the operator.

6.3.5. Chemical Feed System

Chemical addition will be controlled through pH control loops or flow control loops. The instrumentation loops will control the chemical meeting pump ON/OFF cycle and also control the chemical addition rate. The pH control loops will provide a signal either at the PLC or at the MCC to control acid and caustic addition. Polymer and diatomaceous earth addition will be based on the flow control loop, which will be a local loop with display at the PLC.

6.4 OPERATING PROCEDURES

6.4.1. Start Up

Since the support systems will come on line at the same time as the pretreatment and main treatment facilities start up, the support system start up has been discussed in general in Sections 4.0 and 5.0 of this document. Further information is provided in this section.

6.4.1.1. Air Collection System.

- Verify that there are no leaks in the collection piping.
- Verify that the moisture trap and GAC unit are on line.

6.4.1.2. Air Treatment System. Verify that the inlet and discharge valves are in OPEN position.

6.4.1.3 Compressed Air System.

- Verify that valve setting at the air compressor system is per manufacturer's specifications.
- Turn air compressor switches at the MCC to AUTO.
- Turn the individual compressor units local controls to ON.
- Verify that the system operates properly and no unusual noises are detected.
- Verify that the air pressure settings at the compressor and the air receiver are correct and adjusted as required.

6.4.1.4. Facility Water. Verify that the inlet valve is open.

6.4.1.5. Chemical Feed System. Refer to Section 5.0 for the start-up procedures.

6.4.2. Normal Operations

Once is system is fully on line and operating, the treatment facilities will be operate by themselves based on the vendor PLCs and other instrumentation. The system design incorporated complete automation of the support systems; operator attention has been minimized. However, the operator has to conduct routine and preventive maintenance to avoid break downs in the treatment system; perform process monitoring as specified in this document, other project-specific documents or the manufacturer's information; and complete operational logs for record keeping and documentation.

6.4.2.1. Air Collection System. Same as the start-up procedures.

6.4.2.2. Air Treatment System.

- Visually inspect collection piping for damage.
- Perform routine process monitoring procedures as specified.
- If the treatment unit shows poor performance, perform carbon replacement per manufacturer's instructions.

6.4.2.3. Compressed Air System.

- Repeat procedures outlined in the start-up section.
- Perform inspection and maintenance procedures on the compressors and the receiver as required by the equipment manufacturer.
- Verify pressure at the compressor, receiver, and local gauges on a periodic basis.

6.4.2.4. Facility Water. Same as the start-up procedures.

6.4.2.5. Chemical Feed System.

- Check the tank and piping for leaks.
- Verify that chemical solutions are available. Prepare or order fresh stock.
- Verify that the chemical feed pumps are in AUTO position.
- Observe pump for noise, vibration, diaphragm condition.

6.4.3. Shut-Down Procedures

6.4.3.1. Foul Air Treatment System. Manually shut down the inlet and discharge valves. Verify that the flow has stopped through the GAC unit.

6.4.3.2. Compressed Air System.

- Shut down air compressors locally. Turn switch to OFF.
- Turn air compressor switches at MCC to OFF.
- Shut down valves and bleed air from receiver.

6.4.3.3. Chemical Feed System.

- Shut OFF valves from the air compressor.
- Shut OFF discharge valves from the chemical metering pumps.

6.4. TROUBLE SHOOTING

Trouble shooting for foul air collection system involves checking the backflow prevention valves for proper seating. The operational problems that can be encountered for the fouls air treatment system is similar to that discussed for GAC contactors in Section 5.0. Refer to trouble-shooting guide in the air compressor O&M manual for problems encountered with the air compressor system operation.

6.5 PREVENTIVE MAINTENANCE

The operator performs functions pertaining to equipment maintenance in three general categories:

- House keeping
- Equipment inspection
- Routine preventive maintenance for the pretreatment system components.

General house keeping is described in Section 8.0 of this document. Equipment inspection(s) and routine preventive maintenance will be conducted, as a minimum, per the manufacturer's recommendations and at a frequency specified in the manufacturer's literature.

7.0 INSTRUMENTATION AND CONTROL SYSTEMS

7.1 INTRODUCTION

The PGCS treatment facility is equipped with a sophisticated instrumentation and control system which provides a high degree of automation while maintaining a safe operational environment for the facility. The control system consists of several vendor supplied Programmable Logic Controllers (PLCs), a main control panel (MCP), and a motor control center. Primary control of the PGCS treatment system is achieved through the main control panel which consists of the field interface device (FID), the PLC, and the main annunciation panel. The main control panel is the heart of the control system and is used to interface major equipment, provide status indications (tank level, flow, pH, etc.) and to annunciate alarms. Alarm signals for liquid levels, pH and pressure are communicated to the main control panel and/or the PLC to activate/deactivate process equipment, and to ensure continuity of the process flow throughout the treatment system.

This section of the O&M Plan provides a brief description of the process control components, presents the control strategy for the treatment system modules, and then discusses how the equipment interfacing is accomplished. The O&M operator will refer to the vendor literature (Appendix II) for detailed information regarding the control logic for individual equipment within the PGCS facility. The process components include the following:

- Motor Control Center (MCC);
- Field Interface Device (FID);
- Programmable Logic Controller (PLC);
- Annunciation Panel (Display);
- Vendor PLCs.

Although the PGCS treatment facility components are controlled primarily by the main control panel and PLCs, the process control responsibility is assigned to the facility operator. The Operator's duty is to monitor and adjust the process parameters of the individual treatment components and to designate the process flow through the treatment stages, based on the analytical characterization of the groundwater and the process control information.

7.2 PROCESS COMPONENTS

7.2.1. Motor Control Center

Most of the equipment motor starters are provided at the MCC, located in the electrical/instrumentation room in the treatment system building. The MCC receives the main electrical power to the PGCS treatment facility and is responsible for its distribution to the various equipment and control systems.

7.2.2. Field Interface Device

The Field Interface Device, located in the electrical/instrumentation room, provides the communication interface between the field equipment and controls, and the main electrical and control center at the electrical/instrumentation room. The FID communicates between the MCC and/or PLC and the field equipment. It should be noted that in some instances the FID does not participate in the communication path and instead, direct communication is provided.

7.2.3. Programmable Logic Controller

The Programmable Logic Controller, the "brain" of the PGCS treatment facility instrumentation and control system, is located in the electrical/instrumentation room inside the Annunciation Panel. The PLC provides the following functions:

- Processes control signals to and from the field instrumentation and control equipment;

- Performs sequence of events in response to the control signals to activate/deactivate equipment via the MCC and/or the FID;

- Continually tracks the equipment operation condition and alternates between duplicate units (such as pumps).

The program uses preset values for the various operation sequences. As an example, the Influent Equalization Tank has three level set point for activating/deactivating the

Influent Feed Pumps. The preset values may be modified by the Operator only, based on the operation needs of the PGCS treatment facility.

7.2.4. Annunciation Panel

Major status indicators for the process units (such as tank level indicators, flow indicators, pH indicators, etc.) as well as alarm conditions (level alarms, etc.) are included in the Annunciation Panel, located at the electrical/instrumentation room.

7.2.5. Vendor PLCs

Major process units such as UV Oxidation Systems, Chemical Precipitation Unit, Upflow Sand Filter, and Filter Press will be operated via individually dedicated vendor PLCs. The control strategy for each equipment is discussed in Section 7.3.

7.3 SYSTEM INSTRUMENTATION AND CONTROL

7.3.1. Extraction Trench Pumps

Each extraction trench pump has a local control panel (LCP) with a motor starter and a field element for monitoring and controlling the pump. The influent line header from the extraction trench has a flow meter with flow indicator and totalizer located within the treatment building. Each extraction trench pump is equipped with an individual paddle wheel type flow totalizer located at the trench sump. Extraction trench pumps will shut down if any of the following conditions are activated:

- High level in pretreatment tank;
- High level in equalization tank;
- High level in phase separator;
- System shutdown due to other alarm conditions.

Extraction trench monitoring for input to the MCP PLC consists of discrete input signals for trench level used to control the pump. Display on the Annunciation Panel includes pump run status and the trench alarm condition.

7.3.2. Phase Separator

The Phase Separator will be controlled by the LCP, located by the unit. The Phase Separator has two control systems:

- Phase Separator Control Panel which controls the operation of unit itself. The phase separator will be remotely controlled from the MCP.
- Signal transmission to the PLC located within MCP to indicate the system status (on/off) and high-level alarm conditions to the vendor-supplied .

7.3.3. Sludge Storage and Thickening Tank

The Sludge Storage and Thickening Tank will have a level sensor to provide an operating range control signal for the tank mixer motor, and a high-level alarm located on the MCP. The tank mixer motor will be operated manually or automatically based on level in the tank. On a low level the mixer will not operate and a shutdown signal will be sent to the filter press. The tank mixer will have a local and remote control switch (HOA). A mixer status indicator light will be located at the MCP.

7.3.4. NAPL Storage Tank

The NAPL Storage Tank will have a level sensor to provide a tank full indication and a high-level alarm, both displays located at the MCP. The MCP PLC does not provide any type of process control to the NAPL Storage Tank.

7.3.5. Filter Press

The entire operation of the Filter Press will be controlled by the LCP, located by the unit. The LCP will control the operating sequence of the dewatering process, and also the support systems: feed pumps, diatomaceous earth mixing and feed system, polymer feed system, and all other ancillary equipment. On a low-level signal from the sludge storage and thickening tank, the filter press will shutdown. The filter press will have a status indicator light at the MCP. Refer to Appendix II for manufacturer's literature and the equipment O&M catalogs for further information on the Filter Press system operations and control.

7.3.6. Sludge Dewatering Area Sump Pump

The Sump Pump will pump water into the process sump and will be controlled by float switches located in the sump. The pump motor starter and controls for the float switch will be located by the Sump.

7.3.7. Floor Sump Leak Detection

Each Floor Sump will have a high-level sensor which will provide an input into the PLC located at the MCP. Detection of high liquid level in the sump will trigger an alarm on the MCP, and the extraction pumps will be shutdown.

7.3.8. Pretreatment Tank

The Pretreatment Tank will be equipped with a level sensor to provide an operating range control signal for the tank mixer motor, pretreatment pumps, and a high-level alarm at the MCP. The tank mixer motor will be operated manually or automatically based on level in the tank. On a low level the mixer and pretreatment pumps will not operate. The tank mixer will have a local and remote control switch (HOA). A mixer status indicator light will be located at the MCP. A shutdown signal will be sent to the extraction pumps on a high water level in the tank.

7.3.9. Pretreatment Tank Pumps

The Pretreatment Tank Pumps transfer water to the equalization tank based on the level in the pretreatment tank. The pumps will operate in a lead/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start, the lead pump will start. When the level drops enough to stop the pump it will become the lag pump allowing the next pump to start first when the tank level rises. If the tank level continues to rise the lag pump will start. The system logic will start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with both pumps activated. In the event one pump is deactivated (taken off line), the other pump will perform continuously. High pretreatment tank level will trigger an alarm at the MCP.

The pump motor starters will be located at the MCP. The Annunciation Panel display will include run status for both pumps and a HOA switch for remote control.

7.3.10. Equalization Tank

The Equalization Tank will be equipped with an analog level sensor to provide an operating range control signal for the tank mixer motor, influent pumps, and a high-level alarm. The tank mixer motor will be able to be operated manually or automatically based on level in the tank. On a low level, the mixer and influent pumps will not operate. On a high level, a shutdown signal will be sent to the extraction pumps, pretreatment tank pumps, and collection pumps. Also, the high-level alarm light will stay on after the tank level drops until an operator pushes the high-level reset button. The tank mixer will have a local and remote control switch (HOA). A mixer status indicator light will be located at the MCP.

7.3.11. Influent Pumps

The Influent Pumps will be variable speed pumps, used to transfer water to the UV Oxidation unit. The pump operation will be based on the level in the equalization tank and an operator-set flow rate into the oxidation unit. The pumps will operate in a lead/lag/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start, the lead pump will start. When the level drops enough to stop the pump, it will become the lag pump allowing the next pump in sequence to start first when the tank level rises. If the tank level continues to rise and flow is below the set flow rate, the lag pump will start. If the tank level continues to rise the third pump will start unless the operator-set flow rate will be exceeded. On high pH adjustment tank level or oxidation unit failure, the pumps will be shutdown. On a rising pH adjustment tank level rate greater then the set flow rate the pump's speed will be reduced until the level in the pH adjustment tank stops rising. Each pump will have a local and remote hand switch (HOA) and individual remote status indicator lights at the MCP. The system logic will start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with all pumps activated. In the event one or more pumps are deactivated (taken off line), the other pumps will perform continuously.

7.3.12. UV Oxidation System

The entire operation of the UV Oxidation system will be controlled by a vendor-supplied PLC which will interface with the overall control system for the treatment plant. The unit PLC will control the flow of Enox catalyst and hydrogen peroxide based on flow rate through the system. UV light intensity will also be controlled based on the flow rate. The local control system will also control acid feed rate based on pH.

The unit PLC will provide a system on signal to the MCP PLC. The package unit will include a flow meter with indication and flow totalization. It will send a flow control signal to the PLC located in the MCP for use in controlling the chemical feed pumps, influent pumps, and effluent pumps. The system will also provide a means for the operator to enter a flow rate set point that will be sent to the PLC located in the MCP.

7.3.13. Chemical Feed Pumps for pH Adjustment Tank and Effluent Weir Box

These Chemical Feed Pumps will have their rates adjusted by the pH rate signal from the pH meter located in each respective tank. Each pump will have a local and remote hand switch (HOA) and individual status indicator lights at the MCP.

7.3.14. Chemical Precipitation Unit

The Chemical Precipitation Unit (CPU) operations will be controlled by a vendor-provided PLC which will interface with the overall control system for the treatment plant. The CPU PLC will control the flow of polymer based on the flow rate through the UV oxidation system. The rapid mix tank will have a pH sensor which will provide the control signal for acid and base additions. The CPU control system will control the flow of acid and base according to pH in the rapid mix tank. The pH sensor will provide a signal to the PLC located in the MCP. Low pH and high pH alarms will be located at the MCP. The rapid mix, flocculation and plate settling unit will have a remote hand switch (HOA) and individual status indicator lights at the MCP.

7.3.15. Sand Filter

The automatic operation of the Sand Filter will be controlled by the local control system that is part of the Chemical Precipitation Unit. When there is no effluent flow from the oxidation unit the control system will shut down the air supply to the filter.

7.3.16. pH Adjustment Tank

The pH Adjustment Tank will be equipped with an analog level sensor to provide an operating range control signal for the tank mixer motor, influent pumps, effluent pumps, and high level alarm located on the MCP. The tank mixer motor will be able to be operated manually or automatically based on level in the tank. On a low level the mixer and effluent pumps will not operate. A shutdown signal will be sent to the influent pumps on a high level. On a rising tank level rate greater then the set oxidation unit flow rate, a slowdown signal will be sent to the influent pumps to reduced their speed until the level in the tank stops rising. The tank mixer will have a local and remote control switch (HOA). A mixer status indicator light will be located at the MCP. The tank will have a pH sensor that will provide a signal to the PLC located in the MCP. The pH signal will be used to control the acid and base flow rates into the tank. High pH and low pH alarms will be located at the MCP.

7.3.17. pH Adjustment Tank Pumps

These variable speed pumps will operate in a lead/lag/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start the lead pump will start. When the level drops enough to stop the pump it will become the lag pump allowing the next pump in sequence to start first when the tank level rises. If the tank level continues to rise and flow is below the set flow rate, the lag pump will start. If the tank level continues to rise the third pump will start unless the flow rate will be exceeded. Each pump will have a local and remote hand switch (HOA) and individual status lights at the MCP. The system logic will start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with all pumps activated. In the event one or more pumps are deactivated (taken off-line), the other pumps will perform continuously.

7.3.18. Process Sump (Filtrate, Decant Water, Backwash Sump)

The Process Sump will be equipped with a level sensor to provide a control signal for the tank transfer pumps and a high-level alarm at the MCP. On a low level, the transfer pumps will not operate.

7.3.19. Process Sump Pumps

The Process Sump Pumps will operate in a lead/lag sequence to even the operation time on each pump. When the tank level calls for one pump to start, the lead pump will start. When the level drops enough to stop the pump it will become the lag pump allowing the next pump to start first when the tank level rises. If the tank level continues to rise, the lag pump will start. On high equalization tank or separator level the pumps will be shutdown. Each pump will have a local and remote hand switch (HOA) and individual status lights at the MCP. The system logic will start the lag pump in the event the lead pump fails. The above synchronization will be for normal operating conditions with both pumps activated. In the event one pump is deactivated (taken off-line), the other pump will perform continuously.

7.3.20. Weir Box

The Weir Box contains a mixer motor that will be manually controlled with a local hand switch. A pH sensor will be placed such that it sends the pH level of the final effluent stream to the PLC located in the MCP. Chemical feed pumps will be controlled by the signal from the pH meter. Low pH and high pH alarm indicator lights will be located at the MCP. A flow meter with flow indication and totalization will be mounted locally in the weir box. The flow meter will transmit an analog signal to the PLC located in the MCP. The flow signal will be used to control the composite sampler.

7.3.21. Composite Sampler

The composite sampler will be controlled by a built-in logic controller. Effluent samples will be collected based on the flow signal from the flow meter located in the weir box. No controls or display will be provided at the MCP.

7.3.22. Chemical Storage Tanks

All chemical tanks will have local-level indication and low-level sensors to provide a input into the PLC located in the MCP. Each tank will have a low-level alarm located at the MCP.

7.4 SYSTEM FAILURE OR EMERGENCY SHUT DOWN

There are four conditions upon which the PGCS treatment facility will shut down:

- Extraction Trench pump failure - facility will cease operation, PLC will have battery backup for restoration;
- Failure of both pumps associated with a similar function (such as Influent Feed Pumps) - a high-level alarm in the upstream equalization tank(s) will cause facility shut down;
- Failure of any major equipment - either a high-level alarm in the upstream equalization tank(s) will cause facility shut down or the extraction trench pumps will be shut down and the facility will cease operations;
- Failure of Sump Pump - extraction trench pumps will be shut down and the facility will cease operations.

Except during a power failure, all PLCs (including vendor-supplied PLCs) will remain in function during the shut down. Section 10.0 presents the vulnerability analysis of the treatment system components, describes the redundant feature within the treatment facility, and presents a description of alternate operations.

8.0 MAINTENANCE PROGRAM

The PGCS treatment facility is designed for fully automatic operations; full time operator attendance may not be required in the long term. However, the groundwater extraction, treatment, and discharge systems do require scheduled maintenance and monitoring. Maintenance should be conducted promptly in order to prevent emergency occurrences at the facility.

There are three factors which must be considered in the field maintenance: design, construction, and operation. Facility design was established in such a manner that effective maintenance can be performed. Facility construction includes a thorough inspection program (construction management) to minimize the risk of faulty materials or equipment in the PGCS system. Facility operation must carry out the actual maintenance procedures to ensure that the plant routinely meets the purpose of its design in an efficient and safe manner.

8.1 MAINTENANCE CATEGORIES

Maintenance performed at the facility can be categorized into four general classifications described below.

8.1.1. Spare Parts Management

Each major piece of equipment at the PGCS is provided with critical spare parts to accommodate for emergency repairs. The spare parts list is based on the equipment manufacturer's recommendation.

The facility staff will maintain an inventory list for the required spare parts and update the inventory when spare parts are used during maintenance. The facility staff will inform the Plant Superintendent of the spare parts restocking requirements for maintaining a full inventory.

When establishing the initial spare parts list, the Superintendent shall assemble inventory for special tools to ensure the proper tools are used when performing the required maintenance procedures.

8.1.2. Preventive Maintenance

Preventive maintenance is the most crucial program to ensure proper, long-term operation of the PGCS treatment components. It involves service maintenance tasks to prevent or minimize process shut down, to reduce wear on all equipment, and to extend the useful life of equipment and structures.

Preventive maintenance shall be conducted in accordance with the equipment manufacturer's recommendations which are contained in Appendix II of this document. Appendix II will be updated as more information is available.

8.1.3. Routine Maintenance

Routine maintenance (or facility housekeeping) involves the care of the facility building as well as the mechanical equipment. Routine maintenance of the mechanical equipment will be conducted as needed or as specified by the equipment manufacturer.

Walkways and stairways within the facility shall be kept clear of debris and all hosed down often for reasons of health and safety. The laboratory, office, instrumentation room, mechanical room, and other work areas shall be cleaned regularly and kept in good order.

8.1.4. Corrective Maintenance

Corrective maintenance is all work required to repair major equipment malfunctions including complete overhauls and emergency repairs. Maintenance personnel should be prepared to handle this type of emergency work at all times to ensure continuity of the facility operation.

A major item of concern with the execution of corrective maintenance is that these maintenance tasks are generally more complex, thereby requiring more expertise and mechanical aptitude to complete the job. The Superintendent must determine if the work needed to be done can be accomplished by in-house personnel or must be contracted out to a specialized service contractor.

8.2 GENERAL MAINTENANCE CONDITIONS

All maintenance requires considerable skill acquired by experience, study, and practice. All maintenance programs should incorporate a good housekeeping program and should serve the following rules:

- Keep a clean, neat, and orderly operating facility
- Establish a systematic plan for the execution of regular operations
- Establish a routine schedule for inspections and lubrications
- Keep data and records of each piece of equipment, with emphasis on unusual incidents and faulty operating conditions.

Performance of the day-to-day maintenance functions is only one obligation of maintenance personnel. There is the obligation of record keeping on each individual piece of equipment, to include all work performed on that particular unit, along with comments on the overall condition and operating characteristics. Analysis of these records assists in the detection of an impending failure of the piece of equipment and subsequent scheduling of its repair in a timely manner.

8.2.1. Observation of Field Safety

Each operator shall be aware of the dangers and restrictions involved when performing maintenance on any piece of equipment. Employees can be injured on the job from the misuse of tools, lifting heavy objects incorrectly, and/or handling chemical without taking necessary precautions.

8.3 PLANNING AND SCHEDULING

A key to properly maintaining facility operation is detailed planning and scheduling of maintenance functions to be performed. Planning and scheduling shall consider tasks to be performed, time required, personnel skills, special tools or equipment required, work order lead times, availability of parts, environmental factors, parts reorder lead times, equipment replacement schedules, vacations, holidays, and availability of personnel. Scheduling charts with priorities of subjects, personnel, and time shall be used as a planning tool so as to maximize resources and personnel and to help minimize idle time and wasted effort. Those tasks to be performed at a specified interval such as daily, weekly, or monthly, may be grouped accordingly for work scheduling purposes.

8.4 MONITORING AND TESTING PROGRAM

The analytical testing program at the PGCS provides the basis for process control and produces a record of treatment performance for regulatory compliance. The laboratory data keep the operating personnel informed of efficiencies and aids in anticipating problems which may be developed in the treatment system.

Because laboratory test results are a record of the facility performance, they are often received and evaluated by administrators and governing agencies. It is, therefore, essential that a laboratory testing program produce complete and accurate results.

The testing facility is located in the office building and includes all necessary equipment to perform the routine analyses required for operation and regulatory compliance of the treatment facility. The on-site facility serves two functions:

- Provides quick turn around on analysis of effluent samples to verify that the effluent is in compliance with the discharge limitations.

- Provides data for monitoring performance of the various process units.

8.4.1. Compliance Monitoring Program

The compliance monitoring will be conducted in accordance with the Performance Standard Verification Plan (PSVP) for the ACS Site.

8.4.2. Process Monitoring Program

Refer to the PSVP for details on the process monitoring program, including analysis type, frequency, and sampling locations.

8.4.3. Laboratory Equipment And Methods

The laboratory equipment, analytical equipment and methods for on-site analyses and for off-site testing program are detailed in the Quality Assurance Project Plan (QAPjP) for the ACS Site.

8.4.4. Sampling Procedures

The sampling procedures are described in the Quality Assurance Project Plan (QAPjP) for the ACS Site.

8.4.5. Quality Assurance/Quality Control (QA/QC)

The QA/QC procedures are described in the Quality Assurance Project Plan (QAPjP) for the PGCS.

9.0 RECORD KEEPING AND REPORTING

Establishing and maintaining a complete facility records system is vital to an efficient operation and maintenance of the treatment facility. Proper record keeping will fulfill regulatory reporting requirements, create a baseline and criteria for the planning of facility expansions or continued operation, benefit performance evaluation and remedies to periodic treatment problems, and assist in estimating and scheduling maintenance activities and budgets. All required documentation will be maintained and filed at the on-site office and with the ACS Steering Committee.

9.1 OPERATION AND MAINTENANCE RECORDS

9.1.1. Worksheets

The details of daily operations will be summarized and recorded using the daily worksheet. The worksheet will record the time of the day, activity, field sampling and analytical results, visual observations, and any calculations. The worksheets will also serve as a reminder of routine activities to be taken at the treatment facility.

9.1.2. Operation Log

A bound diary or journal-type log book will be maintained by the operator for the treatment facility. Typical readings, startup or shutdown of equipment, occurrence of accidents, major breakdowns, commencement and completion of major maintenance efforts, chemical deliveries, changes in operation, and monitoring sampling will be included in the operation log. Log entries of various activities and problems should be made as they develop so that no items are overlooked.

9.1.3. Summary Records

A summary record is useful in identification of operational trends and forecasting of problems. For most operations, a monthly log arranged in the chronological order and showing equipment performance, chemical consumption, and other facility activities should be included in the summary.

9.1.4. Cost Records

The maintenance of complete cost records is valuable for use in the budgeting and planning efforts. The cost should include utility usage, chemical and shipping costs, equipment rental, and usage costs. Records defining the allocations and costs of labor for the facility should also be maintained.

9.1.5. Reporting

Progress reports will be prepared to transfer operations information from treatment facility to ACS Steering Committee. The ACS Steering Committee will be responsible for providing a summary progress report to th EPA and IDEM. The summary progress report will be submitted along with the laboratory data report.

9.2 LABORATORY RECORDS

Proper performance and interpretation of laboratory analyses will enable the operations staff to maximize efficiency and effectiveness of the various unit processes. Laboratory analyses are also performed to ascertain whether or not compliance with the discharge standards is being achieved; such results shall be reported to the EPA and the IDEM in accordance with the Final FPDES Numbers for Discharge to No Flow Wetlands.

The reporting program requires an adequate record keeping plan in order to maintain credibility. The following are recommended record keeping guidelines, to be exercised at the PGCS treatment facility.

9.2.1. Sample Logs

Before any sample is collected, a significant amount of planning must be performed, as discussed in the Quality Assurance section of this document. The tool utilized to structure this planning is the sample log. Through a sample log, the sample stream, size, collection time and method, mode of preservation, and analysis schedule can all be predetermined, and all quality assurance requirements can easily be fulfilled.

A sample log will be completed for each sample acquired at the treatment facility with the following information written in indelible ink:

- Sample name and/or flow stream
- Exact location of sampling point
- Type of sample (grab or composite)
- Type of preservative, if applicable
- Date and time of collection
- Sampling location
- Analyte(s) or analytical method(s)
- Initials of sampling personnel.

9.2.2. Chain-Of-Custody (COC)

The chain-of-custody procedures will allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. Documentation of custody is accomplished through a COC record that lists each sample and the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if it is:

- In a person's possession
- In view after being in physical possession
- Locked or sealed so that no one can tamper with it after having been in physical custody
- In a secured area, restricted to authorized personnel.

A COC form will be used to record the samples collected and the analyses requested. Information recorded will include time and date of sample collection, sample number, the type of sample, the sampler's signature, the required analysis, and the type of containers and preservatives used.

A copy of the COC record will be retained by the sampler prior to shipment. Shipping receipts will be signed and filed as evidence of custody transfer between field sampler and courier, and courier and laboratory.

10.0 ALTERNATE OPERATION AND MAINTENANCE PROGRAM

10.1 INTRODUCTION

The PGCS treatment facility is equipped with a sophisticated instrumentation and control system which provides a high degree of automation while maintaining a safe operational environment. The treatment facility will be attended by an operator most of the time when the facility is operational. The facility design incorporates alarm signals to provide an advance notification to the operator of impending problems. In addition, a certain amount of redundancy is built into the treatment system design. However, a potential exists for the system failure which may threaten the release of hazardous substances, pollutants or contaminants to the atmosphere and endanger public health or the environment.

This section presents the potential failures that may occur in the treatment system, the impact of these failures on the facility operations, and the alternate operations/corrective actions to be implemented to provide continued treatment of extracted groundwater at the PGCS facility.

10.2 POTENTIAL SYSTEM FAILURE

Potential system failure could occur due to malfunctioning of mechanical equipment or the control logic. Failure of any major equipment could lead to the facility shut down. Table 10-1 presents a vulnerability analysis of the treatment facility components and also identifies the impact of potential equipment failure on the facility operation.

10.3 ALTERNATE PROCEDURE

The treatment facility design provides a high degree of flexibility in conducting alternate operation. For example, failure of the UV Oxidation system could lead to discharge of partially treated water that may exceed the performance standards. However, activated carbon vessels have been provided to counter act the failure of the UV Oxidation system and to provide organic removal commensurate with the discharge standards. Similar redundancy exists for each major component of the treatment facility. Table 10-1 identifies alternate operations that can be conducted in the event of equipment failure.

TABLE 10-1

DESCRIPTION OF ALTERNATE OPERATION

Process Unit	Vulnerability Analysis and Impact	Alternate Operations/Corrective Action
Extraction Trench Pump	• Pump burn out; no groundwater to the treatment system.	• System shut down; no operations.
Phase Separator	• Inadequate oil/grease removal; potential interference with the secondary treatment units or discharge of oil/grease with treated water. • Overflow from the discharge weir; spill of potentially hazardous materials within the facility.	• Ensure that both UV Oxidation and GAC systems are on-line for oil/grease removal. Recycle if necessary. • Secondary containment system will contain the leak. Extra 55-gallons drum provided at the site can be used for storing Oil/LNAPL.
Oil/LNAPL Storage Tank	• Tank leak; spill of potentially hazardous materials within the facility.	• Secondary containment system will contain the leak. Extra 55-gallons drum provided at the site can be used for storing Oil/LNAPL.
Sludge Storage and Thickening Tank	• Tank leak; spill of potentially hazardous materials within the facility. • Mixer failure; fluids pumped to the filter press causing inadequate dewatering.	• Secondary containment system will contain the leak. Extra 55-gallons drum provided at the site can be used for storing sludge. • No major impact on the filter press operation.
Pre-Treatment Equalization Tank	• Mixer failure; not adequate mixing. • Tank leak; spill of potentially hazardous materials within the facility.	• No major impact on the treatment system. • Bypass the Pre-Treatment Equalization Tank and divert groundwater to the Main Equalization Tank.
Pre-Treatment Pumps	• Motor burn out in one pump. • Motor burn out in both pumps; automatic facility shut down thorough the PLC.	• Redundant pump provided with automatic start up. • No operations.
Main Equalization Tank	• Mixer failure; not adequate mixing. • Tank leak; spill of potentially hazardous materials within the facility.	• No major impact on the treatment system. • Secondary containment system will contain the leak. Bypass the leaking tank.

TABLE 10-1

DESCRIPTION OF ALTERNATE OPERATION
(CONTINUED)

Process Unit	Vulnerability Analysis and Impact	Alternate Operations
Main Pumps	• Motor burn out in one pump. • Motor burn out in both pumps; automatic facility shut down thorough the PLC.	• Redundant pump provided with automatic start up. • No operations.
UV Oxidation System	• Failure of UV lamps; no treatment for organic contaminants.	• Bypass UV Oxidation unit; ensure GAC units are on-line for organic treatment.
Chemical Precipitation Unit	• Rapid mix tank mixer failure; reduced treatment efficiency for metals removal. • Loss of removal efficiency in Plate Settler/Thickener; solids carryover. • Chemical feed system failure; no pH adjustment causing solids to stay in suspension.	• Recirculate wastewater through the Main Equalization Tank for additional treatment. Ensure GAC units are on-line for additional removal. • Ensure Upflow Sand Filter is on-line for solids removal. • Ensure that pH Adjustment Tank in on-line. Solids precipitation will occur in the pH Adjustment Tank as the pH is increased. Ensure Upflow Sand Filter is on-line for additional solids removal.
Sludge/Scum Pump	• Interruption of air supply; no solids transfer to Sludge Storage/Thickening Tank.	• No major impact on treatment system. Ensure Filter is on-line for removal of carry-over solids.
Upflow Sand Filter	• Filter backwash system failure; reduced solids removal with plugged filter.	• Bypass filter for backwash. Ensure GAC is on line for additional solids removal.
pH Adjustment Tank	• Mixer failure; inadequate mixing causing pH variations. • Tank leak; spill of potentially hazardous materials within the facility. • Chemical feed system failure; no pH adjustment.	• Redundant system provided in the Effluent Sump and Weir Box. Ensure that the Effluent Sump mixer is operating. • Secondary containment system will contain the leak. • Redundant system provided in the Effluent Sump and Weir Box. Ensure that the Effluent Sump chemical feed system is operating.

TABLE 10-1

DESCRIPTION OF ALTERNATE OPERATION (CONTINUED)

Process Unit	Vulnerability Analysis and Impact	Alternate Operations
Effluent Pumps	• Motor burn out in one pump. • Motor burn out in both pumps; automatic facility shut down thorough the PLC.	• Redundant pump provided with automatic start up. • No operations.
GAC Contactors	• Breakthrough of the Lead GAC unit.	• Lag GAC unit will provide adequate treatment. Either by-pass the Lead GAC unit or ensure that the GAC system is operating in series mode.
Effluent Sump and Weir Box	• Mixer failure; inadequate mixing causing pH variations. • Chemical feed system failure; no pH adjustment.	• Redundant system provided in the pH Adjustment Tank. Ensure that the pH Adjustment Tank mixer is operating. • Redundant system provided in the pH Adjustment Tank. Ensure that the pH Adjustment Tank chemical feed system is operating.
Sludge Pumps	• Motor burn out in one pump. • Motor burn out in both pumps; automatic facility shut down thorough the PLC.	• Redundant pump provided with automatic start up. • No operations.
Filter Press	• Polymer feed failure; inadequate dewatering producing high water content sludge. • Filter Press failure; no sludge dewatering.	• No major impact on the treatment facility operations. • No major impact on the treatment facility operations. Filter Press operations can be stopped while allowing sludge build up in the storage tank.
Sump Pump	• Motor burn out; automatic facility shut down thorough the PLC.	• No operations. The secondary containment system will contain any leaks during that period.
Filtrate, Decant Sump Pumps	• Motor burn out in one pump. • Motor burn out in both pumps; automatic facility shut down thorough the PLC.	• Redundant pump provided with automatic start up. • No operations.

TABLE 10-1

DESCRIPTION OF ALTERNATE OPERATION (CONTINUED)

Process Unit	Vulnerability Analysis and Impact	Alternate Operations
Diffuser System	• Diffuser clogs. • Ice buildup on diffuser	• Switch flow to alternate diffuser. Clear diffuser and feed line via cleanout ports. • Switch flow to alternate diffuser. Remove ice buildup.

These alternate operations should provide continued treatment of extracted groundwater and minimize the impact of system failure on the surrounding environment.

10.4 REPORTING AND RECORD KEEPING

The facility operator will maintain a log of operating problems in the treatment system, potential impacts of operating problems on the system performance, and the corrective actions taken to mitigate the problem. Procedures employed to ensure that the problem does not occur in the future will be also be recorded in the daily log. A copy of the operation log will be forwarded to regulatory agencies as part of the O&M submittals.

11.0 EMERGENCY RESPONSE AND CONTINGENCY PLAN

11.1 PURPOSE

The purpose of the Emergency Response and Contingency Plan (ERCP) is to define procedures to protect human health and the environment both on and off-site in the event of an accident or emergency during the PGCS operation and maintenance activities. The health and safety plan for the PGCS addresses in detail the precautionary measures to be taken during the facility construction. This section delineates the responsibilities for the contractor selected for the PGCS O&M. A written addendum, developed by the O&M contractor, will document all changes to this plan and will add operation-specific emergency response and contingency information, policies, operating procedures, and documentation forms. It will be the O&M contractor's responsibility to implement the ERCP.

11.2 ELEMENTS OF THE ERCP

The O&M contractor shall develop an ERCP for on-site emergencies [29 CFR 1910.120(1)] which should address at a minimum:

- Pre-emergency planning
- Personnel roles, lines of authority, and communication
- Emergency recognition and prevention
- Safe distances and place of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination
- Emergency medical treatment and first aid
- Emergency alerting and response procedure
- Critique of response and follow-up
- Personal protective equipment and emergency equipment

The plan will address these elements during start up, operation and maintenance, and shut down of the treatment facility. The ERCP shall meet the guidelines provided in "Guidance on EPA Oversight Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, Appendix B, Contingency Plan (EPA, 1990)." As suggested by EPA, the ERCP shall include elements to protect the local affected population in the event of an accident or emergency, and include:

- Name of person responsible for responding to an emergency accident
- Plan and date for meeting with the local community
- First-aid and medical information
- Air monitoring plan
- Spill control and countermeasures

11.3 EMERGENCY TYPES

It is essential that facility personnel be prepared in the event of an emergency. Emergencies can take many forms: illness or injuries, chemical exposures, fires, explosions, spills, leaks, releases of harmful chemicals, or sudden changes in the weather.

11.4 AIR MONITORING PLAN

Volatile organic compounds will be monitored during the PGCS operation. Emissions monitoring will be conducted in accordance with the guidelines established by the local regulatory agencies. In addition, a program shall be developed to monitor harmful vapors from release of chemicals during an emergency. Portable field equipment shall be available at the site to adequately characterize the vapors and to plan for personal protective equipment.

11.4.1. Emissions Control Procedures

Process air generated at the PGCS treatment facility will be processed through a vapor-phase GAC. The GAC is considered a Best Available Control Technology (BACT) for removal of volatile organic contaminants.

11.5 SPILL AND DISCHARGE CONTROL PLAN

The PGCS will treat extracted groundwater; hence a potential exists for spill of contaminated groundwater. In addition, several chemicals will be stored on-site to treat extracted groundwater and to analyze treated groundwater. This spill and discharge control plan addresses methods, means, and facilities that will be provided to (1) prevent a spill or uncontrolled discharge of contaminated groundwater or chemicals, (2) prevent further contamination of the environment, structures, equipment, or materials resulting from potential accidental spills, (3) protect the ACS employees from potential hazards at the site, and to (4) ensure public health and safety.

11.5.1. Control Procedures and Protective Measures

The entire treatment facility will have a secondary containment to contain the spilled material. Equipment and personnel will also be provided to perform emergency measures necessary to contain spills and to remove spilled materials and associated contaminated material. A spill kit will be maintained on site during the removal action. The spill kit will contain, at a minimum, a DOT-approved container, sorbing material, shovels and brooms, personnel protective clothing (tyvek, gloves, safety glasses, and industrial boots), and adequate polyethylene sheeting to contain a spill. The waste generated as a result of any spill will be collected on site, properly containerized, and either treated through the facility or transported to an authorized off-site disposal facility.

11.5.2. Decontamination Procedures

Decontamination Procedures may be required after cleanup to eliminate traces of the substances spilled or to reduce it to an acceptable level. Personnel and equipment decontamination shall occur as specified in 29 CFR 1910.120.

11.5.3. Spill Notification

In the event of a spill, the facility operator shall will take the following actions:

- Take immediate measures to control and contain the spill.
- Immediatle notify officials at the ACS facility [(219) 924-4370] so that proper precautionary measures can be taken to protect ACS employees.
- Take necessary steps to clean up the spill, including spilled materials and any materials contaminated by the spill so that the contaminated material no longer presents a hazard to human health or the environment.

- Notify the ACS Steering Committee of the nature of the spill and the response action. The ACS Steering Committee will be responsible for notifying the regulatory agencies within 10 days of any unauthorized spill in accordance with the requirements of 49 CFR 171.15 and other regulatory requirements. The 49 CFR 171.15 requires regulatory notification of unauthorized spills which exceed 450 liters (119 gallons) for liquids and/or 400 kg (882 pounds) for solids, and could be used as a threshold for regulatory notification.

11.6 COMMUNITY RELATIONS PLAN

As part of pre-emergency planning, the O&M contractor shall plan and schedule a meeting with the local communities. The meeting will include representatives from the local, state, and federal agencies who are involved with the PGCS treatment facility. The contractor-prepared addendum to the ERCP will specify the meeting time, place, and attendees.

The O&M contractor shall plan and schedule regular meeting with the local communities, and representatives from the local, state, and federal agencies who are involved with the PGCS treatment facility. The contractor-prepared addendum to the ERCP will specify the meeting time, place, and attendees.

11.7 EMERGENCY ASSISTANCE PLAN

In accordance with 29 CFR 1910.120(1), the O&M contractor will have developed the ERCP that establishes facility evacuation routes and en emergency medical assistance network. The Fire Department, ambulance service, and clinic or hospital room shall be identified and phone numbers for these services posted in a conspicuous place with the facility. Additionally, a vehicle shall be available on site during all work activities to transport injured personnel to the identified emergency medical facilities. A map and directions indicating the fastest route to the clinic/hospital shall be posted.

The O&M contractor shall provide for emergency response equipment and first-aid arrangements. As a minimum, the supplies listed below shall be immediately available for on-site use:

- First-aid equipment and supplies. The equipment and supplies are toe approved by a Certified Industrial Hygienist.

- Emergency eyewash station and shower which meet the approval of the American National Standards Institute (ANSI) Z-358.1.

- Emergency use respiratory equipment sufficient to protect the operator.

- Spill control material and equipment.

- Type ABC fire extinguisher, 10-pound capacity. A minimum of two fire extinguishers shall be available at the site.

11.7.1. Emergency Contact Numbers

American Chemical Service	**(219) 924-4370**
Ambulance	**911**
Fire and Rescue	**911**
Highway Patrol	**911**
Paramedics	**911**
Police	**911**
Sheriff	**911**
Toxic Chemical Spill	**(800) 334-1697**
EPA Emergency Response	**(???) ???-????**
National Response Center	**(800) 424-8802**

Section 8

8.0 PERFORMANCE STANDARD VERIFICATION PLAN

8.1 INTRODUCTION

This section presents the Performance Standard Verification Plan (PSVP) that will be implemented at the ACS Site for the Perimeter Groundwater Containment System (PGCS). The purpose of the PSVP is to delineate the approach to be used to measure performance and to ensure that both short-term and long-term performance standards for this portion of the remedial action are met. The performance standards for this portion of the remedy are:

- Hydraulic containment (determined based on water level measurements) of groundwater in the upper aquifer at the downgradient boundary of the site, and

- Water quality standards established for discharge of the treated groundwater.

No other performance standards, such as the groundwater remediation levels, are applicable since the objective of the PGCS as stated in the RD/RA Work Plan is containment, not restoration. The final remedy for the site will address restoration of the groundwater. Also, this PSVP does not include monitoring the water quality of the contaminant plume since this will be accomplished through the quarterly monitoring program.

The PSVP for this portion of the remedy includes the following plans:

- A Quality Assurance Project Plan (QAPP) which presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the remedial action at the ACS Site. The QAPP also describes the specific protocols to be followed for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses. A Draft QAPP for the ACS Site was submitted in August 1995. An addendum to the QAPP will be included as Attachment A of the Final PSVP.

- A site-specific Health and Safety Plan (HSP) designed to protect on-site personnel and area residents from physical, chemical and all other hazards posed by the remedial action. A Draft HSP for the ACS Site was submitted in August 1995. An addendum to the HSP will be included as Attachment B of the Final PSVP.

- A Performance Monitoring Program which delineates the field measurements, sampling, and analyses to be conducted to monitor the performance of the PGCS.

8.2 PERFORMANCE MONITORING PROGRAM

The PGCS has two components that require performance monitoring: (1) the extraction trench, and (2) the treatment system.

8.2.1. Extraction Trench

The purpose of the extraction trench is to achieve hydraulic containment of contaminated groundwater in the upper aquifer along the downgradient boundary of the ACS Site. Existing piezometers plus new piezometers to be installed within, and adjacent to, the extraction trench will be used to obtain water level measurements. Nine new piezometers will be installed to monitor groundwater levels in and near the trench. The nine piezometers will be installed in three clusters each with three piezometers. One cluster will be located at the midpoint of the northern-northeastern leg of the trench and each the other two clusters will be located one third of the distance along the main length of the trench. One piezometer of each cluster will be installed in the trench, one will be installed 25 feet upgradient, perpendicular to the trench and one will be installed 25 feet downgradient, perpendicular to the trench. Existing piezometers P-23 through 27 located in the vicinity of the trench will also be used for monitoring purposes. In addition, existing piezometers P-30, P-31, P-40 and P-41, located far upgradient will be used as reference piezometers for assessing drawdown in the trench. Periodic water level measurements will be conducted on each piezometer. The water level data will be used to generate groundwater contour maps for evaluating the capture zone of the trench. A preliminary schedule for water level measurements is presented below.

Piezometers	Cumulative Time from Startup	Frequency
All	3 months prior to	Once per week
All	0 to 7 days	Once per day
All	8 to 30 days	Once per week
All	31 days to 1 year	Once per month
All	1 year onward	Once per quarter

8.2.2. Treatment System

The purpose of the groundwater treatment system is to reduce the concentrations of contaminants to acceptable levels prior to discharge to the wetlands. The acceptable levels are the effluent quality standards established by IDEM and U.S. EPA, and as agreed to by the ACS PRP Group. Samples of the treated groundwater will be collected from the effluent sump located in the treatment building. A preliminary schedule of the sampling frequency and analytes is shown in Table 8-1.

TABLE 8-1

GROUNDWATER TREATMENT SYSTEM PERFORMANCE MONITORING PROGRAM

Analytes	Cumulative Time from Startup	Frequency
Flowrate and pH	—	Continuous
BOD and TSS	0 to 7 days	Once per day
	8 to 30 days	Once per week
	31 to 180 days	Once per month
	181 to 365 days	Once per quarter
	366 days onward	Twice per year
VOCs, SVOCs, and Metals	0 to 7 days	Twice
	8 to 30 days	Once per week
	31 to 180 days	Once per month
	181 days onward	Twice per year
PCBs	0 to 7 days	Once
	8 to 30 days	Once
	31 to 180 days	Twice
	181 days onward	Twice per year

APPENDIX A

EVALUATION OF GROUNDWATER TREATMENT ALTERNATIVES

MEMORANDUM

MONTGOMERY WATSON

To:	ACS Technical Committee	**Date:**	September 15, 1995
From:	Phil Heck, Ron Schlicher	**Reference:**	4077.0105
Subject:	Cost Analysis of Groundwater Treatment Alternatives		

Attached are cost estimates for the 3 preferred groundwater treatment alternatives for the ACS Site. Treatment Alternatives A, B, and C are for the revised dewatering scenario which would provide treatment of groundwater from the perimeter groundwater containment system (PGCS), the on-site containment area (ONCA) dewatering system, and relatively low flows from the gradual dewatering of the off-site containment area (OFCA) and still bottoms pond (SBP). The three alternatives are briefly described below:

- **Alternative A.** Groundwater from the SBP and OFCA would pass through a phase separator and would then be blended with groundwater from the PGCS and ONCA. The combined flow would be treated in a metals removal system followed by an air stripper and granular activated carbon (GAC) polishing units. Contaminated air from the stripper would be treated by vapor phase GAC. Sludge from the phase separator and metals removal system would be dewatered using a plate and frame filter press.

- **Alternative B.** Groundwater from the SBP and OFCA would pass through a phase separator and would then be blended with groundwater from the PGCS and ONCA. The combined flow would be treated in a metals removal system followed by biological activated carbon (BAC) system and GAC polishing units. Sludge from the phase separator, metals removal system, and BAC would be dewatered using a plate and frame filter press.

- **Alternative C.** Groundwater from the SBP and OFCA would pass through a phase separator and pretreatment UV oxidation system. It would then be blended with groundwater from the PGCS and ONCA. The combined flow would be treated in a second UV oxidation system followed by a metals removal system and GAC polishing units. Sludge from the phase separator and metals removal system would be dewatered using a plate and frame filter press.

The costs for the three alternatives are presented in Tables 1, 2, and 3 which are attached to this memorandum. The alternative using UV oxidation (Alternative C) has the lowest overall present worth even though the capital cost is about 10 percent higher than Alternative A (air stripping and GAC). The high present worth of Alternative A is due to the high costs for replacement and disposal of the liquid and vapor phase GAC. The present worth for Alternative B is between the two other alternatives. The operation and maintenance costs of Alternative B are lower than either of the other alternatives, but the capital cost is much higher. Based on the costs presented in this memorandum, the alternative using UV oxidation (Alternative C) is the recommended alternative.

The cost estimates presented in Tables 1, 2, and 3 assume that the wastestream flow and characteristics will not change. In the long term, however, the wastestream flow will likely decrease to about 20 gpm and the characteristics will be essentially the same as the PGCS stream. Consequently, a cost analysis was also performed on Treatment Alternatives A and C assuming that only low-strength groundwater from the PGCS and ONCA would be treated. This analysis was conducted to confirm that Alternative C would be the most cost-effective alternative in the absence of the high organic loading from the OFCA and SBP source areas. For this analysis, the two alternatives were modified so that only the equipment necessary for treatment of the low-strength waters was included. These alternatives are designated Alternative A* (air stripping and GAC) and Alternative C* (UV oxidation) and the costs for each alternative are contained in Tables 4 and 5, respectively. The capital cost of Alternative A* is higher than Alternative C*, but the operations and maintenance costs are lower. The two alternatives, however, have nearly identical total present worth and therefore this analysis confirms the cost-effectiveness and selection of UV oxidation for groundwater treatment at the site.

TABLE 1

**COST ESTIMATE FOR
TREATMENT ALTERNATIVE A: AIR STRIPPING WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS**

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(1 of 2)

No.	Item	Description	Quantity	Cost
1A.	**EQUIPMENT COSTS**			
1.	Phase Separator	20-gpm oil/water/solids separation unit	1	**$30,000**
2.	Oil Storage Tank	6,500-gallon oil storage tank	1	**$25,000**
3.	Equalization Tank	5,000-gallon stainless steel tanks	2	**$48,000**
4.	Air Stripper	Air Stripping Tower for VOC removal	1	**$65,000**
5.	Filter Press	Filter press for sludge dewatering	1	**$95,000**
6.	Sand Filtration	Sand filter for solids removal	1	**$35,000**
7.	Chemical Storage Tanks	2,500-gallon storage tanks	3	**$22,500**
8.	Metal Removal	Metals removal system	1	**$80,000**
9.	Sludge Storage Tanks	6,500-gallon storage tanks for oily sludge and metals sludge	2	**$40,000**
10.	Vapor Phase Carbon System	Off-gas treatment from air stripper	1	**$15,000**
11.	Liquid Phase Carbon Polishing Unit	Carbon contactors	2	**$50,000**
			EQUIPMENT COST SUBTOTAL	**$505,500**
1B.	**SYSTEM INSTALLATION COST**			
1.	Equipment Installation	Equipment set-up, freight charges	40% of E.C.	**$202,200**
2.	Pipe Fittings	Valves, piping, pipe fittings	25% of E.C.	**$126,400**
3.	Electrical	Power hook-up, electrical tie-ins	5% of E.C.	**$25,300**
4.	Instruments and Controls	Instrumentation for process control and system automation	15% of E.C.	**$75,800**
6.	Mechanical Costs	Containment system for pipes, conduit runs, miscellaneous costs	10% of E.C.	**$50,600**
7.	Building Cost	Treatment system housing building	6,000 ft^2 @ \$65/ft^2	**$390,000**
			SYSTEM INSTALLATION COST SUBTOTAL	**$870,300**
1C.	**CONTRACTOR'S OVERHEAD AND PROFIT**	General Contractor's costs and profits	20% of I.C.	**$174,000**
1D.	**ENGINEERING OVERSIGHT SUPPORT**	Construction management	5% of I.C.	**$43,500**
			EQUIPMENT AND INSTALLATION COST	**$1,593,300**
			CONTINGENCY COST 25% of E.C. &I.C.	**$398,300**
			CAPITAL COST	**$1,991,600**

E.C.=Equipment Cost
I.C.=Installation Cost

TABLE 1

COST ESTIMATE FOR
TREATMENT ALTERNATIVE A: AIR STRIPPING WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(2 of 2)

No.	Item	Description	Unit Cost	Cost/Year 8000HRS/YR
TREATMENT ALTERNATIVE 1: OPERATIONS COST				
1.	Power Requirement	System Operation Costs	$0.1/KWH	**$40,000**
2.	Carbon Usage	Vapor & Liquid Phase Carbon Usage @$1.50/lb	$1,930/Day	**$675,500**
3.	Sludge Disposal	Off-site sludge disposal of dewatering sludge (0.8 tons/day @$240/ton plus haul cost)	$192.0/day	**$67,200**
4.	Chemical Dosage	Nutrient/chemical addition for (20 lbs/day @$5/lb)	$100/day	**$35,000**
5.	Labor	Plant labor to operate/monitor (50 hrs/week)	$50/hr	**$130,000**
			TOTAL OPERATIONS COST/YEAR	**$947,700**
Present Worth (n=5 yrs, i=10%)				**$5,583,000**

TABLE 2

COST ESTIMATE FOR
TREATMENT ALTERNATIVE B: BAC WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(1 of 2)

No.	Item	Description	Quantity	Cost
1A.	**EQUIPMENT COSTS**			
1.	Phase Separator	20-gpm oil/water/solids separation unit	1	**$30,000**
2.	Oil Storage Tank	6,500-gallon oil storage tank	1	**$25,000**
3.	Equalization Tank	5,000-gallon stainless steel tanks	2	**$48,000**
4.	BAC Unit	Two Model 190 GAC-fluid beds	2	**$540,000**
5.	Filter Press	Filter press for sludge dewatering	1	**$125,000**
6.	Sand Filtration	Sand filter for solids removal	1	**$35,000**
7.	Chemical Storage Tanks	2,500-gallon storage tanks	3	**$22,500**
8.	Metal Removal	Metals removal system	1	**$80,000**
9.	Sludge Storage Tanks	6,500-gallon storage tanks for oily sludge, biological sludge, and metals sludge	2	**$40,000**
10.	Liquid Phase Carbon Polishing	Carbon contactors	2	**$25,000**
			EQUIPMENT COST SUBTOTAL	**$970,500**
1B.	**SYSTEM INSTALLATION COST**			
1	Equipment Installation	Equipment set-up, freight charges	40% of E.C.	**$388,200**
2.	Pipe Fittings	Valves, piping, pipe fittings	25% of E.C.	**$242,600**
3.	Electrical	Power hook-up, electrical tie-ins	5% of E.C.	**$48,500**
4.	Instruments and Controls	Instrumentation for process control and system	15% of E.C.	**$145,600**
5.	Mechanical Costs	Containment system for pipes, conduit runs, miscellaneous costs	10% of E.C.	**$97,500**
6.	Building Cost	Treatment system housing building	6,000 ft^2 @ $65/$ft^2$	**$390,000**
			SYSTEM INSTALLATION COST SUBTOTAL	**$1,312,400**
1C.	**CONTRACTOR'S OVERHEAD AND PROFIT**	General Contractor's costs and profits	20% of I.C.	**$262,500**
1D.	**ENGINEERING OVERSIGHT SUPPORT**	Construction management	5% of I.C.	**$65,620**
			EQUIPMENT AND INSTALLATION COST	**$2,611,000**
			CONTINGENCY COST 25% of E.C. &I.C.	**$652,800**
			CAPITAL COST	**$3,264,000**

E.C.=Equipment Cost
I.C.=Installation Cost

TABLE 2

COST ESTIMATE FOR
TREATMENT ALTERNATIVE B: BAC WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(2 of 2)

No.	Item	Description	Unit Cost	Cost/Year 8400HRS/YR
TREATMENT ALTERNATIVE 2: OPERATIONS COST				
1.	Power Requirement	System Operation Costs	$0.1/KWH	**$20,000**
2.	Carbon Usage	Liquid Phase Carbon Usage @$1.50/lb	$51/day	**$18,000**
3.	Sludge Disposal	Off-site sludge disposal of dewatering sludge (2.0 tons/day @$240/ton plus haul cost)	$480/day	**$168,000**
4.	Chemical Dosage	Chemical addition for (20 lbs/day @$5/lb)	$100/day	**$35,000**
5.	Labor	Plant labor to operate/monitor (50 hrs/week)	$50/hr	**$130,000**
6.	GAC-Fluid Bed Operation Cost	Oxygen, nutrients, additional costs (150 lb/day @ 0.5/lb)	$75/day	**$26,000**
			TOTAL OPERATIONS COST/YEAR	**$397,000**
Present Worth (n=5 yrs, i=10%)				**$4,769,000**

TABLE 3

COST ESTIMATE FOR
TREATMENT ALTERNATIVE C: ADVANCED OXIDATION WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(1 of 2)

No.	Item	Description	Quantity	Cost
1A.	**EQUIPMENT COSTS**			
1.	Phase Separator	20-gpm oil/water/solids separation unit	1	**$30,000**
2.	Oil Storage Tank	6,500-gallon oil storage tank	1	**$25,000**
3.	Equalization Tank	5,000-gallon stainless steel tanks	2	**$48,000**
4.	Advanced Oxidation Unit	UV Oxidation System	2	**$163,000**
5.	Filter Press	Filter press for sludge dewatering	1	**$95,000**
6.	Sand Filtration	Sand filter for solids removal	1	**$35,000**
7	Chemical Storage Tanks	2,500-gallon steel storage tanks	3	**$22,500**
8.	Metal Removal	Metals removal system	1	**$80,000**
9.	Sludge Storage Tanks	6,500-gallon storage tanks for oily sludge and metals sludge	2	**$40,000**
10.	Liquid Phase Carbon Polishing	Carbon contactors	2	**$16,000**
			EQUIPMENT COST SUBTOTAL	**$554,500**
1B.	**SYSTEM INSTALLATION COST**			
1.	Equipment Installation	Equipment set-up, freight charges	40% of E.C.	**$221,800**
2.	Pipe Fittings	Valves, piping, pipe fittings, pumps	30% of E.C.	**$166,400**
3.	Electrical	Power hook-up, electrical tie-ins	5% of E.C.	**$27,700**
4.	Instruments and Controls	Instrumentation for process control and system automation	15% of E.C.	**$83,200**
6.	Mechanical Costs	Containment system for pipes, conduit runs, miscellaneous costs	10% of E.C.	**$55,400**
7.	Building Cost	Treatment system housing building	6,000 ft^2 @ $65 ft^2	**$390,000**
			SYSTEM INSTALLATION COST SUBTOTAL	**$944,500**
1C.	**CONTRACTOR'S OVERHEAD AND PROFIT**	General Contractor's costs and profits	20% of I.C.	**$188,900**
1D.	**ENGINEERING OVERSIGHT SUPPORT**	Construction management	5% of I.C.	**$47,200**
			EQUIPMENT AND INSTALLATION COST	**$1,735,000**
			CONTINGENCY COST 25% of E.C. &I.C.	**$433,800**
			CAPITAL COST	**$2,169,000**

E.C.=Equipment Cost
I.C.=Installation Cost

TABLE 3

COST ESTIMATE FOR
TREATMENT ALTERNATIVE C: ADVANCED OXIDATION WITH GAC FOR THE *COMBINED* PGCS, ONCA, OFCA, AND SBP WASTEWATERS

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(2 of 2)

No.	Item	Description	Unit Cost	Cost/Year 8400HRS/YR
TREATMENT ALTERNATIVE 3: OPERATIONS COST				
1.	Solarchem Unit Operations Costs	System Operation Costs	$550.8/Day	**$192,780**
2.	Sludge Disposal	Off-site sludge disposal of dewatering sludge (0.8 tons/day @$240/ton plus haul cost)	$192.0/day	**$67,200**
3.	Chemical Dosage	Chemical addition for (20 lbs/day @$5/lb)	$100/day	**$35,000**
4.	Carbon Polishing	Liquid phase carbon usage @$1.50/lb	$51/day	**$18,000**
5.	Labor	Plant labor to operate/monitor (50 hrs/week)	$50/hr	**$130,000**
			TOTAL OPERATIONS COST/YEAR	**$442,980**
Present Worth (n=5 yrs, i=10%)				**$3,847,900**

TABLE 4

COST ESTIMATE FOR
TREATMENT ALTERNATIVE A*: AIR STRIPPING WITH GAC FOR THE *PGCS WASTEWATER ONLY*

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(1 of 2)

No.	Item	Description	Quantity	Cost
1A.	**EQUIPMENT COSTS**			
1.	Equalization Tank	5,000-gallon stainless steel tanks	1	**$24,000**
2.	Air Stripper	Air Stripping Tower for VOC removal	1	**$65,000**
3.	Filter Press	Filter press for sludge dewatering	1	**$65,000**
4.	Sand Filtration	Sand filter for solids removal	1	**$35,000**
5.	Chemical Storage Tanks	2,500-gallon storage tanks	3	**$22,500**
6.	Metal Removal	Metals removal system	1	**$80,000**
7.	Vapor Phase Carbon System	Off-gas treatment from air stripper	1	**$15,000**
8.	Sludge Storage Tank	6,500-gallon storage tank for metals sludge	1	**$7,000**
9.	Liquid Phase Carbon Polishing Unit	Carbon contactors	2	**$50,000**
			EQUIPMENT COST SUBTOTAL	**$363,500**
1B.	**SYSTEM INSTALLATION COST**			
1.	Equipment Installation	Equipment set-up, freight charges	40% of E.C.	**$145,300**
2.	Pipe Fittings	Valves, piping, pipe fittings	25% of E.C.	**$90,900**
3.	Electrical	Power hook-up, electrical tie-ins	5% of E.C.	**$18,200**
4.	Instruments and Controls	Instrumentation for process control and system	15% of E.C.	**$54,500**
6.	Mechanical Costs	Containment system for pipes, conduit runs, miscellaneous costs	10% of E.C.	**$36,400**
7.	Building Cost	Treatment system housing building	6,000 ft^2 @ $65/$ft^2$	**$390,000**
			SYSTEM INSTALLATION COST SUBTOTAL	**$735,300**
1C.	**CONTRACTOR'S OVERHEAD AND PROFIT**	General Contractor's costs and profits	20% of I.C.	**$147,000**
1D.	**ENGINEERING OVERSIGHT SUPPORT**	Construction management	5% of I.C.	**$368,000**
			EQUIPMENT AND INSTALLATION COST	**$1,283,000**
			CONTINGENCY COST 25% of E.C. &I.C.	**$320,700**
			CAPITAL COST	**$1,604,000**

E.C.=Equipment Cost
I.C.=Installation Cost

TABLE 4

COST ESTIMATE FOR
TREATMENT ALTERNATIVE A*: AIR STRIPPING WITH GAC FOR THE *PGCS WASTEWATER ONLY*

AMERICAN CHEMICAL SERVICES, INC. NPL SITE

No.	Item	Description	Unit Cost	Cost/Year 8000HRS/YR
TREATMENT ALTERNATIVE 4: OPERATIONS COST				
1.	Power Requirement	System Operation Costs	$0.1/KWH	**$12,000**
2.	Carbon Usage	Vapor & Liquid Phase Carbon Usage @$1.50/lb	$115/Day	**$40,000**
3.	Sludge Disposal	Off-site sludge disposal of dewatering sludge (0.4 tons/day @$240/ton plus haul cost)	$96/day	**$33,600**
4.	Chemical Dosage	Nutrient/chemical addition for (20 lbs/day @$5/lb)	$100/day	**$35,000**
5.	Labor	Plant labor to operate/monitor (50 hrs/week)	$50/hr	**$130,000**
			TOTAL OPERATIONS COST/YEAR	**$250,600**
Present Worth (n=5 yrs, i=10%)				**$2,554,000**

TABLE 5

COST ESTIMATE FOR
TREATMENT ALTERNATIVE C*: ADVANCED OXIDATION WITH GAC FOR THE *PGCS WASTEWATER ONLY*

AMERICAN CHEMICAL SERVICES, INC. NPL SITE
(1 of 2)

No.	Item	Description	Quantity	Cost
1A.	**EQUIPMENT COSTS**			
1.	Equalization Tank	5,000-gallon stainless steel tank	1	**$24,000**
2.	Advanced Oxidation Unit	UV Oxidation System	1	**$71,000**
3.	Filter Press	Filter press for sludge dewatering	1	**$65,000**
4.	Sand Filtration	Sand filter for solids removal	1	**$35,000**
5.	Chemical Storage Tanks	2,500-gallon steel storage tanks	3	**$22,500**
6	Metal Removal	Metals removal system	1	**$80,000**
7.	Sludge Storage Tank	6,500-gallon storage tanks for oily sludge and metals sludge	1	**$7,000**
8.	Liquid Phase Carbon Polishing	Carbon contactors	2	**$16,000**
			EQUIPMENT COST SUBTOTAL	**$320,500**
1B.	**SYSTEM INSTALLATION COST**			
1.	Equipment Installation	Equipment set-up, freight charges	40% of E.C.	**$128,200**
2.	Pipe Fittings	Valves, piping, pipe fittings, pumps	30% of E.C.	**$96,200**
3.	Electrical	Power hook-up, electrical tie-ins	5% of E.C.	**$16,000**
4.	Instruments and Controls	Instrumentation for process control and system automation	15% of E.C.	**$48,000**
6.	Mechanical Costs	Containment system for pipes, conduit runs, miscellaneous costs	10% of E.C.	**$32,000**
7.	Building Cost	Treatment system housing building	6,000 ft^2 @ $65 ft^2	**$390,000**
			SYSTEM INSTALLATION COST SUBTOTAL	**$710,400**
1C.	**CONTRACTOR'S OVERHEAD AND PROFIT**	General Contractor's costs and profits	20% of I.C.	**$142,000**
1D.	**ENGINEERING OVERSIGHT SUPPORT**	Construction management	5% of I.C.	**$35,500**
			EQUIPMENT AND INSTALLATION COST	**$1,208,400**
			CONTINGENCY COST 25% of E.C. &I.C.	**$302,100**
			CAPITAL COST	**$1,510,500**

E.C.=Equipment Cost
I.C.=Installation Cost

TABLE 5

COST ESTIMATE FOR
TREATMENT ALTERNATIVE C*: ADVANCED OXIDATION WITH GAC FOR THE *PGCS WASTEWATER ONLY*

AMERICAN CHEMICAL SERVICES, INC. NPL SITE

No.	Item	Description	Unit Cost	Cost/Year 8400HRS/YR
TREATMENT ALTERNATIVE 5: OPERATIONS COST				
1.	Solarchem Unit Operations Costs	System Operation Costs	$196/Day	**$68,500**
2.	Sludge Disposal	Off-site sludge disposal of dewatering sludge (0.4 tons/day @$240/ton plus haul cost)	$96/day	**$33,600**
3.	Chemical Dosage	Chemical addition for (20 lbs/day @$5/lb)	$100/day	**$35,000**
4.	Carbon Polishing	Liquid phase carbon usage @$1.50/lb	$25/day	**$9,000**
5.	Labor	Plant labor to operate/monitor (50 hrs/week)	$50/hr	**$130,000**
			TOTAL OPERATIONS COST/YEAR	**$276,600**
Present Worth (n=5 yrs, i=10%)				**$2,559,000**

APPENDIX B

RESULTS OF VENDOR-CONDUCTED TREATABILITY STUDIES

MEMORANDUM

MONTGOMERY WATSON

To:	ACS Technical Committee	**Date:**	September 15, 1995
From:	Phil Heck, Ron Schlicher and Joe Adams	**Reference:**	4077.0120
Subject:	Bench-Scale Treatability Studies		

The results and conclusions from the bench-scale treatability study conducted by the three UV oxidation system vendors are briefly summarized in this memorandum. Recommendations on equipment selection are also provided. The studies were conducted to confirm the ability and performance of advanced oxidation processes (AOPs) for treatment of both low-strength groundwater from the Perimeter Groundwater Containment System (PGCS) and high-strength mixtures of groundwater from the PGCS and source areas. The primary goals of the bench-scale testing were to:

- Demonstrate that AOP technology can remove the contaminants of concern in the groundwater at the ACS Site.
- Identify potential fouling problems of the AOP technology when treating wastes containing high inorganics and metals concentrations such as exist at the ACS Site. This includes defining pretreatment requirements for the source area wastestreams.
- Provide data for sizing of a full scale treatment system.
- Optimize the AOP technology for the specific suite of constituents at the ACS Site. This includes optimization of the hydraulic residence time, oxidant dosage, UV dosage, and lamp replacement frequency.
- Develop accurate O & M requirements and costs from the optimization information.
- Obtain accurate equipment proposals from vendors.

The bench-scale studies were conducted by three equipment vendors; Solarchem (Markam, Ontario), Vulcan Peroxidation Systems, Inc. (Tucson, Arizona), and Zimpro Environmental (Rothchild, Wisconsin). To conduct the testing, samples of groundwater from the PGCS and source areas were collected and shipped to vendors Low-strength groundwater similar to the water expected from the PGCS was collected from the pump test well at the site. Two 55-gallon drums of this water were sent to both Solarchem and Vulcan and ten 1-gallon glass bottles were sent to Zimpro. An additional sample of PGCS water was sent to Montgomery Watson's analytical laboratory for analysis of inorganics, volatile organics, semi-volatile organics and PCBs.

High-strength source area water was collected from both the OFCA and SBP areas using geoprobes. A 50:50 mixture of water collected from the two areas was blended in a

55-gallon drum. An initial sample of the blended mixture was sent to Montgomery Watson's laboratory for analysis of the parameters listed above. After blending and initial sampling, the drum was sealed and the mixture was allowed to sit quiescently for 24 hours, during which time the mixture separated into three layers; a bottom layer of sludge and dense nonaqueous phase material, a middle aqueous layer, and a top layer of low density non-aqueous phase material (oil and grease). The middle aqueous layer was separated from the other two layers by using a peristaltic pump to withdraw liquid from the middle of the drum. Two 5-gallon drums of the aqueous phase were sent to Solarchem, and Vulcan, and two 1-gallon bottles were sent to Zimpro. Additional samples were collected and sent to Montgomery Watson's laboratory for analysis of the parameters listed above.

Groundwater from the PGCS showed only minor contamination. Of the organic compounds detected, benzene was present in the highest concentration (26 ppb) while ethylbenzene and toluene were also present in the 1 to 2 ppb concentration range. All other volatile compounds that were detected were present at levels less than 1 ppb and all semi-volatile compounds were below the detection limit. Iron was the major inorganic contaminant and it caused the water to have a pale yellow-orange color. Iron was present at approximately 13 mg/l. The organic compound concentrations in the PGCS water (particularly benzene) were significantly lower than in previous sampling events of similar water at the ACS Site. Therefore, the vendors were instructed by Montgomery Watson to spike samples of the PGCS water with 10 mg/l of benzene prior to conducting bench testing.

The material collected from the source areas contained a significant concentration of free phase organic material and oil and grease as well as high concentrations of suspended solids and inorganic pollutants as shown in the attached table (Table C-1). The majority of the organic material, O&G and suspended solids were removed in the phase separation process (24 hour settling) along with a significant quantity of the metals (Table C-1). Many of the individual organic compounds that were present at concentrations above their aqueous solubility in the source material were removed to levels significantly below their solubility level after phase separation. Based on the analytical data for the separated and unseparated samples, and the significant removals achieved by phase separation, it can be concluded that most of the individual organic compounds and some of the metals (i.e. cadmium, chromium, copper, lead, nickel and zinc) that were identified in the source area material preferentially partition into either the LNAPL phase, which is itself measured by the oil and grease analysis, or the sludge. The oily material in effect, appeared to "solvent extract" many of the organic compounds from the water. When the oil and grease was removed by phase separation, most of the individual organic compounds were removed as well. The data also indicates that more hydrophobic compounds such as BTEX, naphthalene and PCE were removed to a greater extent than less hydrophobic and more polar compounds such as acetone and 2-butanone. This supports the "solvent extraction" effect, as hydrophobic compounds would be extracted to a greater extent than hydrophilic compounds. The metals that were removed in significant amounts were most likely adsorbed to suspended solids which were removed as sludge. Iron, which was present at a very high concentration was only marginally removed by settling (21% removal), indicating that it was present in a soluble (reduced) form or as an extremely fine colloidal precipitate.

Vendors were instructed to conduct two sets of bench scale tests. The first set of tests were to be performed on samples of the PGCS groundwater. The second set of tests were to be performed on samples of the settled source area groundwater blended with the PGCS water at a 1:4 ratio (1 part source water blended with 4 parts PGCS water). The 1:4 blend was intended to be representative of the mixture that would occur should waters generated from gradual dewatering of the source areas be blended with waters from the PGCS and ONCA during future remediation activities at the site. The vendors were instructed to optimize their systems around treatment of both samples of water. Following optimization, two of the vendors (Zimpro and Vulcan) were to conduct confirmation runs on both wastestreams and then send both influent and effluent samples to Montgomery Watson's laboratory for analysis. Vendors were also asked to provide alternative treatment strategies for treating the two types of waters (PGCS and the mixture) using advanced oxidation technology if difficulties were encountered in treating either type of water as instructed. Following testing, the vendors were asked to prepare a detailed report of their testing and the results that were obtained. The report was to contain equipment proposals for the equipment necessary to treat both the PGCS water and the mixture as well as chemical dosage rates and expected operations and maintenance costs.

The results from the three vendors are briefly summarized below. The O&M costs in the summary are slightly different than those provided by each vendor. The costs from the vendors have been adjusted so that consistent flowrates and costs for power and chemicals are used to calculate the overall O&M costs for each system.

Zimpro Environmental, Inc. Zimpro failed to complete the testing program required by the contract they received. They did not send initial or final samples to Montgomery Watson's laboratory for testing and were not reimbursed for the work that was performed. They did perform a limited amount of testing on the benzene spiked PGCS water and the mixture of PGCS and source area waters. The Zimpro treatment system was effective in removing benzene from the PGCS water, but was not applicable for treating the mixture. A benzene concentration of 11,644 μg/l in the spiked PGCS water was reduced to 5 μg/l after 20 minutes reaction at a peroxide dose of 15 mg/l and ozone dose of 23 mg/l. For treatment of the PGCS water at a flowrate of 50 gpm the capital cost of a Zimpro - Ultrox system is $150,000 and the operating costs are approximately $1.00/1,000 gallons including chemicals for pH adjustment. Severe fouling problems due to the high iron concentration were anticipated with the mixture and, therefore, it was not tested in the oxidation system. Zimpro did conduct one test on the mixture using Fentons reagent (hydrogen peroxide with a reduced iron catalyst at low pH) and obtained reductions in TOC and benzene concentrations from 82,810 mg/l to 14,200 mg/l and 5,136 mg/l to 3,434 mg/l, respectively after 60 minutes.

Vulcan Peroxidation Systems. The Vulcan system was also able to effectively treat the spiked PGCS water but had trouble treating the mixture. The effectiveness of the Vulcan system on the PGCS water was confirmed by testing of influent and effluent samples by Montgomery Watson. In the spiked PGCS water, a benzene concentration of 10,227 μg/l was reduced in the Vulcan system to <1 μg/l after 30 seconds at a peroxide dose of 100 mg/l and a proprietary catalyst dose of 3 mg/l. COD, O&G and TSS were also partially destroyed in the system. For treatment of the PGCS water at a flowrate of 50 gpm the capital cost of a Vulcan system is $73,000 and the operating costs are approximately $2.04/1,000 gallons including chemicals for pH adjustment.

Severe fouling problems due to the high iron concentration were anticipated with the mixture and pretreatment for removal of iron and suspended solids was required prior to bench testing through the oxidation system. Confirmation samples of the mixture (effluent from oxidation system) were not sent to Montgomery Watson's laboratory for testing, however, an influent sample of the 1:4 blend was submitted for analysis. For the mixture, significant removal of many organic compounds was achieved, but the final levels were above the proposed discharge limits. The difficulty in removing the individual organic compounds was attributed to the high TOC of the water which scavenged hydroxyl radicals and interfered with the treatment process. Vulcan recommended further testing of the mixture, particularly pretreating the source area water prior to blending with the PGCS water, however, they did not have time to complete this work.

Solarchem. As with the other two systems, the Solarchem system was able to effectively treat the spiked PGCS water, however, in an effort to reduce the bench testing costs, confirmation by Montgomery Watson's laboratory was not performed on influent and effluent samples. In addition to testing the PGCS water, Solarchem also performed testing of the mixture and of the source area water itself. Because of the self-cleaning mechanisms contained within the Solarchem system, fouling or other problems associated with treatment of the mixture and source water were not encountered and pretreatment for removal of iron and suspended solids was not required. In fact, Solarchem was able to use the dissolved iron present in the groundwater as a catalyst in the treatment of the PGCS water, the mixture and source water. The process proposed by Solarchem combines the Fentons reagent process with a UV oxidation process. For treatment of the PGCS water at a flowrate of 50 gpm the capital cost of a Solarchem system is $71,000 and the operating costs are approximately $2.72/1,000 gallons including chemicals for pH adjustment.

Solarchem did not recommend blending the source water with the PGCS prior to treatment. The recommended method of treating both the PGCS and source waters would be to treat the source water separately in a pretreatment system prior to blending with the PGCS water. The combined flow would then be treated through a second UV reactor. Pretreatment of the source water would involve heating the water to approximately 130° F, reducing the pH to 3, and adding a high peroxide dose. The reduced iron present in the water would catalyze the Fentons reaction while at the same time the water would be circulated through a UV oxidation reactor. For treatment of the source water at a flowrate of 13 gpm the capital cost of a system is $92,000 and the operating costs are approximately $19.00/1,000 gallons including chemicals for pH adjustment and steam for heating the influent stream from 50 to 130° F. The actual operating costs may be somewhat lower if heat from the effluent stream can be used to preheat the influent stream. Following pretreatment, water would be mixed with low-strength water and would be treated through the system described in the previous paragraph. The total capital cost for treating both waters would be $163,000.

Recommended System. Solarchem is the recommended vendor for supplying a UV oxidation system for treatment of groundwater at the ACS Site. Even though the Solarchem system has a higher expected O&M costs for treatment of the PGCS water than the other two systems that were tested, it has several advantages due to the complex nature of the groundwater at the site. The major water quality complexity driving the selection of the oxidation unit is the high dissolved iron concentration in the groundwater at the site. The advantages of the Solarchem system in regard to iron concentration at the site include the following:

- The Solarchem system has a self cleaning mechanism consisting of automatic wipers for the UV lamps. The other two systems do not have this feature. This cleaning system prevents the buildup of iron deposits (rust) on the lamps. These deposits, if not frequently removed, block light transmission to the fluid and organic contaminants and thus reduce treatment efficiency. Without this automatic cleaning system, frequent shutdown and manual cleaning or lamp replacement would be necessary or the iron in the water would have to be removed to an acceptable level prior to the oxidation process (discussed below).

- For the reasons presented above, the Ultrox and Vulcan systems would require the removal of iron to less than 5 mg/l even when treating only PGCS water. This would require the metals removal system to be located before the oxidation system, which would complicate design and operation of the system because of the VOCs present in the water. If located before the oxidation system, the metals removal system would have to be enclosed and vented which would interfere with operator access and process control. Locating the metals removal system after the oxidation system would allow the system to be open to the building atmosphere and would ensure that the sludge produced in the metals removal process would be free of volatile organic compounds. A "clean" sludge would make sludge handling less complicated particularly in regard operator exposure and ventilation of sludge dewatering and storage systems.

- In the metals removal process, hydrogen peroxide would have to be added to the metals removal system influent to oxidize reduced iron into the insoluble oxidized form. Locating the oxidation system before the metals removal system would allow the reduced iron to be oxidized to an insoluble form in the oxidation system before entering the metals removal process. The cost of the peroxide required for iron oxidation is not included in the O&M costs for the Ultrox and Vulcan systems, while it is included in the Solarchem costs since the hydrogen peroxide required to oxidize both the organics and the dissolved iron would be added in the Solarchem process. Therefore, the costs associated with the Ultrox and Vulcan systems would actually be closer to the costs for the Solarchem system if the costs for the peroxide necessary for iron oxidation were added the peroxide costs for the Ultrox and Vulcan systems.

- For treatment of the source area waters, Solarchem clearly has the best approach and treatment equipment. The other two vendors were not able to handle the high iron and organic content of the water. One of the two vendors even indicated in a phone conversation that the Solarchem system would be the best oxidation system for treating the source waters because of the high iron concentration. Since the system that would be initially installed would treat primarily PGCS water with the intention of future expansion to treat source area waters, the Solarchem system would be the obvious choice. In addition to the technical advantages the Solarchem system offers, the service and responsiveness of their sales and technical personnel was far superior than either of the other two vendors.

Because the source water (OFCA and SBP) quality is extremely variable, the water is difficult to treat, and because effluent samples of treated OFCA and SBP water from Solarchem were not sent to Montgomery Watson's laboratory for analysis, independent confirmation of the effectiveness of UV oxidation on the source water has not yet been obtained. Therefore, further treatability studies on the source water are recommended prior to final selection of a pretreatment system. These studies could be carried out most effectively after the PGCS treatment system is operational and after some of the source area dewatering wells are installed. With the PGCS treatment system on-line, a large volume of source area water (several thousand gallons) could be extracted from the dewatering wells, passed through the phase separator and stored in the pretreatment equalization tank. The actual quality of the source water could then be more accurately characterized and a pilot oxidation system could be used to conduct studies on the water. With better water quality characterization data and treatment process optimization data, the need for a pretreatment system and, if needed, the design of a system could be more accurately assessed.

TABLE C-1

BENCH-SCALE TESTING
REMOVAL OF CONTAMINANTS FROM HIGH-STRENGTH GROUNDWATER BY PHASE SEPARATION

Constituent	Units	Source Stream: 50:50 SBP:Offsite, raw	Source Stream: 50:50 SBP:OffSite, separated	Source Stream: Aqueous Solubility	Source Stream: % Removal By Phase Separation
Water Quality Parameters					
pH	Std Unit	6.32	5.81		
Dissolved oxygen	mg/l	NA	NA		
Temperature	degree C	NA	NA		
Specific conductance	µmHos/cm	NA	NA		
Hardness, total	mg/l-CaCO3	NA	NA		
Residue, diss (TDS)	mg/l	NA	NA		
Residue, susp (TSS)	mg/l	12400	391		96.847
Alkalinity, total	mg/l-CaCO3	NA	NA		
BOD (a)	mg/l	8370	14,700		-75.627
COD	mg/l	79500	26,000		67.296
Carbon (TOC)	mg/l	NA	NA		
Oil and grease	mg/l	30200	74		99.755
Anions					
Chloride	mg/l	NA	NA		
Nitrogen, TKN	mg/l as N	NA	NA		
Phosphorus, total	mg/l as P	NA	NA		
Sulfate	mg/l	NA	NA		
Cations					
Antimony	mg/l	NA	NA		
Arsenic	mg/l	0.046	0.028		39.130
Cadmium	mg/l	0.96	0.543		43.614
Calcium	mg/l	NA	NA		
Chromium, total	mg/l	2.23	0.05		97.758
Copper	mg/l	5.61	0.27		95.187
Iron	mg/l	489.00	386.00		21.063
Lead	mg/l	9.6100	0.1050		98.907
Magnesium	mg/l	NA	NA		
Manganese	mg/l	NA	NA		
Mercury	mg/l	NA	NA		
Nickel	mg/l	2.09	0.78		62.679
Potassium	mg/l	NA	NA		
Selenium	mg/l	NA	NA		
Sodium	mg/l	NA	NA		
Thallium	mg/l	NA	NA		
Zinc	mg/l	33.10	19.00		42.598

TABLE C-1

BENCH-SCALE TESTING
REMOVAL OF CONTAMINANTS FROM HIGH-STRENGTH GROUNDWATER BY PHASE SEPARATION

Constituent	Units	Source Stream: 50:50 SBP:Offsite, raw	50:50 SBP:OffSite, separated	Aqueous Solubility	% Removal
Organics					
Acetone (b)	µg/l	1,710,000	241,000	misc	85.906
Benzene	µg/l	9,640,000	7,150	1,791,000	99.926
bis(2-Chloroethyl)ether	µg/l	ND	ND		
bis(2-Ethylhexyl)phthalate	µg/l	320,000	120		99.963
2-Butanone	µg/l	974,000	272,000	239,000	72.074
Butyl benzyl phthalate	µg/l	27,000	10		99.963
Chloroethane	µg/l	*	230	5,740,000	*
Chloromethane	µg/l	*	1,940	6,500,000	*
4-Chloro-3-methyphenol	µg/l	ND	ND		
1,2-Dichlorobenzene	µg/l	569,000	10	156,000	99.998
1,1-Dichloroethane	µg/l	7,130,000	74,200	5,060,000	98.959
1,2-Dichloroethane	µg/l	*	909	8,524,000	
1,1-Dichloroethene	µg/l	168,000	80		99.952
1,2-Dichloroethene-cis	µg/l	359,000	451	3,500,000	99.874
1,2-Dichloroethene-trans	µg/l	358,000	20		99.994
1,2-Dichloropropane	µg/l	ND	ND		
Diethyl phthalate	µg/l	*	40		
2,4-Dimethylphenol	µg/l	ND	ND		
Dimethyl phthalate	µg/l	*	380		
Di-n-butyl phthalate	µg/l	65,000	10		99.985
Ethylbenzene	µg/l	6,200,000	664	206,000	99.989
Isophorone	µg/l	77,000	10		99.987
Methylene chloride	µg/l	936,000	22,000	13,000,000	97.650
4-Methyl-2-pentanone	µg/l	2,900,000	29,600	19,100,000	98.979
4-Methylphenol	µg/l	ND	ND		
Naphthalene	µg/l	2,410,000	38	34,400	99.998
2-Nitrophenol	µg/l	ND	ND		
Phenol	µg/l	ND	ND		
Tetrachloroethene	µg/l	35,200,000	2,450	150,300	99.993
Tetrahydrofuran	µg/l	ND	ND		
Toluene	µg/l	31,400,000	22,600	534,800	99.928
1,1,1-Trichloroethane	µg/l	14,600,000	16,500	1,495,000	99.887
Trichloroethene	µg/l	7,650,000	3,670	1,000,000	99.952
Trichlorofluoromethane	µg/l	128,000	34	1,100,000	99.973
Vinyl chloride	µg/l	25,800	80	60,000	99.690
Xylenes, total (c)	µg/l	35,000,000	1,400	175,000	99.996

(a) Increase in BOD likely due to removal of inhibitory compounds during phase separation.
(b) Miscible with water.
(c) Solubility listed is for the most soluble isomer (*ortho*).
* - Not detected in influent, probably due to interference by other organic compounds.

NA - Not Analyzed
ND - Not Detected